China's entrance to WTO, the influence of intellectual property rights protection reform on technology diffusion

Meng, Wei

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Wei Meng

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Summary

This thesis aimed to explore the influence of intellectual property rights (IPRs) protection reform gained from WTO accession on technology diffusion in China. China's entrance to the WTO in 2001 brought and will continue to bring significant impacts on China's economic, political and social development. Under pressure from the developed countries, China reformed its IPRs protection in order to accede to the WTO. There was heated debate on whether stronger IPRs protection was beneficial for developing countries' technological progress. This research investigated the impact of IPRs protection reform arising from WTO accession on technology diffusion in China.

Fieldwork was the main method of this research. Semi-structured interview, self-completion questionnaire, official statistics and other sources such as television programs, interviews with government officials were used to collect data.

The research found that its entrance to the WTO urged China to reform its IPRs protection. IPRs reform had both positive and negative impacts on technology diffusion. The impact of IPRs reform on technology diffusion in China varied in different industries, sizes and legal status of firms. Other relevant policies, such as the "Open Door" policy, economic development policies, research and development (R&D) policies, foreign investment policies, China's big market and industry development policies also influenced the impact of IPRs on technology diffusion.

The importance of this research was based on the fact that it was the first research on the impact of IPRs reform on technology diffusion in China which disseminated unique and original information. Currently most Chinese policy-makers intend to implement stronger IPRs policy, without a comprehensive knowledge of the disadvantages of IPRs in technology diffusion. This research will help future policy making as it provided information on the limitations of the current IPRs system, which has not been a matter of concern to the Chinese policy-makers so far.

List of abbreviations

Intellectual property rights……...IPRs

World Trade Organisation……...WTO

Research and Development…….R&D

The Agreement on Trade-related Aspects of Intellectual Property Rights……TRIPS

World Intellectual Property Organisation……..WIPO

International Property Committee…….IPC

General Agreement on Tariffs and Trade……...GATT

Foreign Direct Investment…….FDI

Multinational Companies……..……MNCs

Chinese Communist Party……CCP

People's Republic of China…….P.R.C

Chapter 1

Introduction

1.1. Research context

The development of science and technology has increasingly become an important factor that influences economic progress. IPRs protection has turned into one of the most important and concerning topics, since it is not only a crucial method for protecting firms' technology, but also a legal instrument for stimulating "industrial development and economic growth" for governments (Wallerstein, Mogee and Schoen, 1993:3). This trend became stronger after IPRs had been integrated into the WTO, because this integration made IPRs to be part of global science, technology development, international trade and other relevant areas. This research focuses on IPRs protection and its influence.

IPRs protect "investments in innovations by granting the innovator a temporary monopoly on the use of the innovation" (Wallerstein, Mogee and Schoen, 1993:3). This implies that IPRs ensure that innovators benefit from investing in innovations by providing innovators with a temporary monopoly power to prevent imitation. According to WTO, IPRs protection refers to "the rights given to persons over the creations of their minds" (WTO, 2006a). "They usually give the creator an exclusive right over the use of his/her creation for a certain period of time" (WTO, 2006a). IPRs are generally classified into two areas: "copyright and rights related to copyrights", and "industrial property" (WTO, 2006a). Copyright is used to protect rights of authors in their literary and artistic works and usually gives protection for "a minimum period of 50 years" after the author's death (WTO, 2006a). The "rights related to copyrights" are applied to protect performers' and broadcasting organisations' rights (WTO, 2006a). The aim of

"copyright and the rights related to copyright" is to create incentives for inventive works by providing rewards (WTO, 2006a). Industrial property can also be classified into two categories: distinctive sign protection, such as trademarks and geographical indications, and the protection for innovation, design and technology, such as patent,s "industrial designs and trade secrets" (WTO, 2006a). The purpose of distinctive signs protection is to encourage and assure impartial competition by offering information about products and services to consumers. The main aim of the protection for innovations, designs and technology is to create incentive for innovations by providing rewards. Currently, IPRs protection had been integrated into WTO through the establishment of the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS), which is one of the three important agreements of WTO. The TRIPS agreement set up minimum standards for IPRs for each WTO member state (Salokannel, 2006:463), and it also integrated basic "concepts of IPRs protection from prior treaties" (Maskus, 1998:133). Any country that wants to accede to the WTO, must accept TRIPS agreement. Therefore, based on these backgrounds, IPRs protection has more far-reaching and potential influence, which is worthy of being researched.

IPRs protection, especially the implementation of the TRIPS agreement in the global area, had many impacts in different areas, such as "implications for innovation, research and development, economic development, the future location of industry, and the global division of labour" (Sell, 2003:9). "Technology diffusion is the dissemination of technical information and knowledge and the subsequent adoption of new technologies and techniques by users" (Queensland Government, 2006). According to WTO, the settlement of the TRIPS agreement had two main purposes: creating incentives for innovation to promote technological development and encouraging technology transfer (WTO, 2006b). These two purposes both connected with technology diffusion. Therefore, technology diffusion became one of the most important aspects of IPRs protection.

IPRs protection was originally established and developed in the western world (David,

1993:44]. The developed countries have comparatively mature IPRs protection systems. Moreover, the integration of IPRs protection into the WTO was advocated by most developed countries, such as the USA, the European Union and Japan (Stegemann, 2000:1241). For developing countries, IPRs protection was a relatively new area, and most developing countries just introduced their IPRs protection system from WTO accession under the pressure of developed countries. Therefore, there were many issues arising from IPRs protection systems in the developing world, which need to be researched. The relationship between technology diffusion and IPRs protection is one of the most important issues among them, because for developing countries, promoting technology development and diffusion is quite urgent.

1.2. The research questions

As one of the biggest developing countries in the world, China's development in economics and politics, especially the rapid development during recent period, has drawn great attention from all over the world. In 2001, China's entry into the WTO after almost fifteen year of endeavour was a significant event for the progress of Chinese economics and politics, which had brought and continues to bring extensive impacts on China. The influence on IPRs protection in China arising from WTO accession is of particular concern, because China has a very short history of IPRs protection and IPRs has great relationship with technological and economic development. In order to accede to the WTO and under the pressure from developed countries, especially from the USA, China made many reforms to its IPRs protection policy in the past, especially in the period from the late 1980s to the 1990s. The world has witnessed the establishment and rapid development of IPRs protection in China in the past 25 years and especially during the period of China's trying to accede to the WTO (Cao, 2007:ix). The implementation of the TRIPS agreement also meant that China has strengthened its IPRs protection, because the minimum standards set up by the TRIPS agreement for IPRs protection were higher than those in China at that time. According to the WTO, the TRIPS agreement has two main purposes: creating incentives for innovation to promote

technological development and encouraging technology transfer (WTO, 2006b). However, whether stronger IPRs protection can bring benefits for developing countries in technological progress is still an issue. Some people consider that stronger IPRs protection cannot only be beneficial to developed countries but also be helpful to developing countries in technological development and diffusion. However, others believe that stronger IPRs protection cannot bring benefits for the development and diffusion of technology, especially for developing countries. Whether China can get benefits for its technology diffusion from implementing a stronger IPRs protection policy is worthy of being researched. Therefore, this research explores whether the stronger IPRs protection arising from WTO accession can bring positive or negative influences for technological development and diffusion in China.

The main purpose of this research is to explore whether the reform of IPRs protection during entry to the WTO can bring benefits to technology development and diffusion or not in China and to analyse the reasons. This research divided technology diffusion into two aspects—domestic technology development and technology transfer from foreign countries, in order to make the analyses systematically. Thus, this research explored impact of strong IPRs protection obtained from WTO accession on domestic technology development and technology transfer from foreign countries in China. It summarised the impacts in these two parts to conclude the general results. This research also focused on patent and copyright, which were the most important parts of IPRs protection and were the most important parts of IPRs that had relation with technology diffusion.

In order to explore and analyse the influence on technology diffusion in China by stronger IPRs protection obtained in the process of China's entry to the WTO, a series of research objectives should be successfully achieved. These different research objectives were established as following:

- Identify the concept of IPRs protection and its categories.
- Explore alternative theories that support the establishment of IPRs as well as theories that are more critical of IPRs.

- Explain the meaning of technology diffusion.
- Discuss the link between IPRs protection and technology diffusion from alternative perspectives.
- Examine the development of China's IPRs protection policy.
- Explore the link between IPRs protection and technology diffusion in China and compare these findings with similar previous researches.

1.3. Research methods

This research reviewed published theories on IPRs to clarify the concepts and their characteristics. Moreover, a review of the literatures about technology diffusion was also indispensable, since it could provide the concepts and properties of technology diffusion which were the bases of planning and doing fieldwork for this research. In addition, relevant development on IPRs protection in China was also explored to provide the research backgrounds.

The main method of this research was doing fieldwork in China. This fieldwork used semi-structured interviews, which were held mainly with technological executives of selected Chinese firms. The fieldwork also included self-completion questionnaires, which were done with technological executives of selected Chinese firms. Some relevant statistics were collected in this research. In addition, information from other sources such as television programs and interviews with relevant government officials were collected and compared with data obtained through the above methods. Personal connections were an important factor for accomplishing this fieldwork, because without recommendations through personal connections, it would be very difficult for these executives to accept interviews and questionnaires. However, the use of personal connections should not affect the objectivity of fieldwork data, as it had only played a role as an introducer and was not involved in detailed content of this fieldwork. The research methods are explained in detail in chapter five.

Finally, conclusions were drawn through combining analytical results of different

fieldwork data. These conclusions were compared with the relevant literature to obtain unique factors about the impact of IPRs reform on technology diffusion in China.

1.4. The importance of this research

Firstly, this is the first research about the impact of IPRs protection reform on technology diffusion in a particular country—China. There were some articles that discussed the relationship between IPRs protection and some aspects of technology diffusion. Yang (2003) and Yueh (2009) found that with implementing stronger IPRs protection policy, the use of IPRs protection system in China, especially the use of patents, copyrights and trademarks were increased dramatically. Meyer (2001) and Awokuse and Yin (2009 and 2010) concluded that better IPRs protection encouraged imports and FDI through creating favourable environment, which could have positive impacts on technology transfer from foreign countries to China. Bosworth and Yang (2000) also found that stronger IPRs protection had positive impacts on technology transfer through licensing in China. Certainly, there were some articles discussing that stronger IPRs did not have positive impacts on some aspects of technology in China. Lanoszka (2000) and Yu (2007) concluded that stronger IPRs did not have positive impacts on FDI, which was an important channel of obtaining technology transfer from foreign countries to China. These articles researched the relationship between stronger IPRs protection and technology diffusion in some aspects, such as the use of IPRs protection, technology transfer through importing, FDI and licensing. They did not investigate the full scale relationship between stronger IPRs protection and technology diffusion, including domestic technology development and technology transfer through important channels such as international trade, FDI, licensing and imitation. This research explored it. Thus, it is the first research about the impact of IPRs protection reform on technology diffusion in China. Moreover, previous articles used either the analyses of official statistics or economic models to do the investigation. No one has done this research through using fieldwork. Fieldwork was a very important and interesting method for this research, which helped to find out more detailed and

fascinating information from selected samples. Thus, the method using fieldwork also provided contributions for this research. Secondly, this research explored the impact of IPRs protection reform on technology diffusion in firms with different legal statuses and sizes in China. No one explored this issue until now. Thirdly, this research found some important, detailed and unique information about the impact of IPRs protection reform on technology diffusion in China. Besides more detailed explanations in the later parts of this thesis, three important and unique characteristics are provided here as examples. 1. IPRs protection reform did not have a great influence on technology transfer from foreign countries for the petroleum sector. Because petroleum is a very important product for a nation's security, technology in this sector is strictly controlled by firms and governments. Moreover, China has a different ideology from developed countries, so it is still difficult to get petroleum technology transferred from developed countries, which hold the most advanced petroleum technologies, even after China reinforced its IPRs protection. 2. Stronger IPRs protection encouraged more domestic technology than technology transfer from foreign countries in China. 3. Without good IPRs protection policy, Chinese firms with production capabilities that were difficult to build in a short time could still get benefits to cover their cost in doing R&D; and there would be still some technology transfers because China's big open market attracted foreign companies to transfer their technology to China. Fourthly, this research result is very helpful for Chinese police-makers. Currently, the Chinese government considers that stronger IPRs protection is good, which leads to the fact that Chinese policy-makers intend to implement stricter IPRs protection, without an understanding of the limitations of IPRs protection in technology diffusion. This research result can help Chinese police-makers to understand that there are some limitations in the current IPRs protection system, which may help future policy decisions. Finally, this research is very useful for future theoretical development in considering alternative IPRs protection systems.

1.5. Structure of the thesis

The second chapter explores the process of integrating IPRs into the WTO. The

historical review helped to understand the purpose of IPRs establishment and the fact that developed countries persuaded developing countries to implement strict global IPRs protection by the WTO, which was an important background of this research. This chapter also analyses the main theories that supported IPRs establishment, which are Locke's "labour theory of property", Hegel's "necessity of private property" theory and the Utilitarian view. The Utilitarian view on IPRs was based on economic analysis. Many debates about IPRs focused on IPRs' impact on economic development, and countries also tried to get economic benefits by using the legal instrument of IPRs and economic analysis of IPRs was related to this research. Therefore, this chapter emphasises the economic analysis of the Utilitarian view on IPRs. This chapter also explores arguments against IPRs, including reasons for these arguments and some comments, advantages and disadvantages of these arguments.

Implementing the TRIPS agreement caused the level of IPRs protection in many countries to be improved, especially in many developing countries and the least developed countries that either had none or very limited IPRs system before accepting TRIPS. There were heated debates about whether IPRs protection or the stronger IPRs protection brought by TRIPS could bring benefit for promoting technology development and diffusion for a country. The third chapter reviews arguments related to IPRs protection and technology diffusion. It focuses on patents and copyrights and their relationship to technology diffusion. Arguments related to IPRs protection and technology diffusion are analysed at country level rather than the world level. Technology diffusion is also divided into two groups for a country, which are domestic technology development and technology transfer from foreign countries, in order to make the analyses systematic. Finally, it also analyses other important factors that had direct and indirect relation with IPRs protection and technology diffusion. Generally, for IPRs protection and domestic technology development, there were three kinds of argument. Some researchers considered that IPRs protection or stronger IPRs protection could promote domestic technology development, others stated that stronger IPRs protection had negative impact on domestic technology development, and yet others

believed that the relation between IPRs protection and domestic technology development depended on other factors, such as different industrial sectors, different characteristics of innovations, different market characteristics and other relevant policies. For IPRs protection and technology transfer from foreign countries, there were different channels including formal and informal channels that could bring technology transfer. This chapter focuses on the main channels for technology transfer, including international trade, foreign direct investment (FDI), licensing and imitation.

The fourth chapter provides background information on IPRs development in China and introduced its IPRs history. Like most other developing countries, China has a very short history on IPRs regulations. Although there were some IPRs regulations after the foundation of People's Republic of China in 1949, the real establishment of IPRs protection regulation started after the country implemented the "Open Door" policy in the late 1970s. Generally, there were three IPRs development climaxes, which occurred in early 1980s, early 1990s and the period from the mid 90s to the beginning of the 21st century. IPRs establishment and development in China resulted from several factors, including internal factors and external pressures from foreign countries, especially those developed countries, which are also analysed in this chapter.

The fifth chapter introduced the research methodology. As mentioned before, this research used fieldwork to collect data. This chapter explains fieldwork questions, explores the main methods used for collecting data in the fieldwork, which are semi-structured interview, self-completion questionnaire, and collecting data from official statistics and other sources. This chapter analyses the reasons and limitations for using these methods. The detailed plan for this fieldwork and the difficulties experienced in the process are also explained in this chapter.

The sixth chapter provides the results of analysing fieldwork data collected from interviews, questionnaires, official statistics and other sources. This chapter introduces the process of analysing semi-structured interview data and self-completion questionnaire data. The main points of analysing interview data and questionnaire data

are also explained. The summaries of analysing official statistics and other sources are presented. This chapter does not provide analyses using relevant arguments. The seventh chapter explores the theoretical analyses of fieldwork results using relevant arguments.

The seventh chapter applies alternative arguments on IPRs protection and its relation to technology diffusion to analyse fieldwork results. It firstly draws results from fieldwork analyses through combining the summary of different data, then theoretically analyses fieldwork results using arguments about IPRs protection and technology diffusion in different aspects. These analyses showed the similarities and differences between results of this research and the relevant literature.

The eighth chapter assembles the summary and main conclusions for this research. It summarises the research questions, purposes and processes, generalizes the main findings and conclusions for this research, highlights the importance and strength of this work, and at last, it puts forward some recommendations for future work.

Chapter 2

Historical development of intellectual property rights (IPRs) protection and its theories

2.1. Introduction

IPRs protection, as defined by the WTO (2006a), refers to "the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period of time". With the rapid increase of the role of information and technology in promoting economic development and the expansion of international trade, IPRs have become a universal focus, which can be observed through the many arguments continuing in this area. IPRs protection was originally established in western countries. IPRs protection was integrated into the WTO system under the persuasion of the developed countries, especially the USA. The history of integrating IPRs protection into WTO showed that developed countries pushed developing countries to implement strict global IPRs protection under the WTO. It also showed that developing countries were not willing to accept the global IPRs protection system established by the TRIPS agreement in the WTO, which provided clues for understanding the relationship between IPRs and technology diffusion, especially in developing countries. Thus it is necessary to know the history of integrating IPRs into the WTO. Moreover, there are various disagreements related to the justification of IPRs. It is important to understand these disagreements, since they explain the basic principles underlying the economic and social effect of IPRs protection. This chapter explores the main theories that support the establishment of IPRs, which are Locke's "labour theory of property" (Hughes, 1988a), Hegel's "necessity of private property" theory (Richards, 2002:528) and the Utilitarian view.

Finally, this chapter introduces different arguments against IPRs, including the Libertarian view on IPRs, arguments that are against intellectual monopoly and arguments that prefer to reform IPRs system, since these arguments provide alternative criticisms of the IPRs system. Although current IPRs protection can be divided into different categories, "the industrial intellectual property (patents) and literary or artistic intellectual property (copyrights)" aroused more arguments and discussions (May and Sell, 2006:7). Patents and copyrights are two most important parts that have particular association with technology diffusion, so the discussion of the different arguments in this chapter focuses on patents and copyrights.

2.2. IPRs integration into the WTO

One of the most important IPRs developments was its integration into the WTO giving rise to the TRIPS agreement. However, the process of IPRs integration into the WTO was largely under the pressure of the USA and other developed countries.

USA companies, especially companies in the pharmaceutical, chemical, software, and entertainment sectors, which held patents and copyrights, worried that their products might be imitated or copied at very low cost by other countries, especially by developing countries (May and Sell, 2006; Stegemann, 2000). The high level of growth in "the East Asian economies", led by "Japan, South Korea, Taiwan, Hong Kong, Singapore" and other New Industrial Economies, such as China, Malaysia, Thailand and so on, was seen by western countries, especially the USA, as being achieved through the copying and imitation of new technologies created in highly developed countries at quite low cost (Kumar, 2002:4). American companies with vested interests in patents and copyrights persuaded the USA government to make relevant trade diplomatic policies. The fact that it was easy for companies to get technically appropriate knowledge and information together with the fact that imitated products had been distributed widely pushed developed countries' governments to take actions "on behalf of their national corporate interests" (May and Sell, 2006:153). The USA government

initially tried to get better IPRs protection and stronger enforcement of that protection through the World Intellectual Property Organisation (WIPO), but it failed because the WIPO is one of the agencies of the United Nations, which takes decisions by a "one-nation, one-vote" process, and developing countries were strongly against better IPRs protection. Another problem was that there was no "dispute settlement mechanism" in the WIPO (Stegemann, 2000). Some American companies established the International Property Committee (IPC) in order to put pressure on the USA government to add IPRs protection to the agenda of multinational trade negotiations related to the General Agreement on Tariffs and Trade (GATT). The IPC also persuaded the "industrial associations in Europe and Japan" to sustain the appeal of the IPC that added IPRs protection into "Uruguay Round" (May and Sell, 2006:154). Then the USA government had to take strict trade policy on IPRs protection such as "Special 301 section of the Omnibus Trade and Tariff Act", which evaluated foreign countries', especially developing countries' IPRs protection and then took strict trade policies towards unsatisfactory countries each year (May and Sell, 2006:155; Stegemann, 2000:1239-1240). Eventually, the USA persuaded the Uruguay Round to add IPRs protection to the negotiations (Stegemann, 2000:1241). Moreover, the USA government also persuaded other western countries, especially the EU to stand on the same side with the USA to support the establishment of better IPRs protection worldwide. At the same time, other countries, including developing countries, wanted to obtain market access into the USA (Stegemann, 2000:1241). However, the USA government did not intend to change domestic regulations on IPRs protection, instead it promised more market access, such as agricultural market access and cancelling restrictions for textile exports to other countries, especially to developing countries, if other countries accepted to improve their IPRs protection. Many developing countries had to make concessions and accept the TRIPS agreement (May and Sell, 2006:155). Consequently, developing Countries made compromises to achieve IPRs protection agreements for the WTO, in order to obtain their market access in developed countries. The general principle of the WTO—that a single undertaking principle made countries, which wanted to become members of the WTO, had no choice but to accept the TRIPS agreement (Stegemann,

2000:1242-1243). After the Uruguay Round, TRIPS was formed as one of agreements in the WTO. According to May and Sell (2006:158), from the brief history of integrating IPRs into the WTO, one may conclude that the establishment of TRIPS was pushed by political processes, and was also brought about by "specific industrial and national interests". TRIPS as "a far-reaching agreement" had and continues to have significant impacts on 'innovation, research and development, economic development" and other relevant issues (May and Sell, 2006:158).

The history of integrating IPRs protection into the WTO was one of pressure from developed countries. Developing countries did not want to establish a strict global IPRs protection system. From their point of view, developing countries saw no advantage on a global IPRs protection system. Otherwise they would have been very glad to accept the TRIPS agreement. However, implementing a strict global IPRs system would undoubtedly bring great benefits for developed countries, which can be perceived from the determined pursuit of a global IPRs system by firms and governments of developed countries. This illuminated a great conflict of interest between developed and developing countries. Finally, the developing countries made great compromises to achieve the TRIPS agreement. Based on this historical background, it is wise to explore the impact of stronger IPRs protection on developing countries, especially for the technological development and diffusion which are the main concerns of developing countries.

2.3. Theories that support IPRs

In general, there are three theories that support the establishment of IPRs. Two of them are "Locke's labour theory of property" (Richards, 2002:523) and Hegel's personhood theory of property and are arguments from natural rights, which believed that innovators should "have a certain right" to their inventions and works because they had created them (Weber, 2002:11). The other one is a utilitarian view, which justified IPRs from an economic viewpoint. There were many debates and criticisms about Locke's and

Hegel's arguments, which can be found in Hettinger (1989) and Richards (2002). These debates are about the natural rights to IPRs. This research is about IPRs and technology diffusion, it does not aim to test the validity of natural rights to IPRs. This research is empirical, so this chapter provides a general introduction to IPRs theories rather than offering a detailed discussion of them.

2.3.1. Locke's labour theory of property

Locke put forward the "labour theory of property" (Richards, 2002:523), which was rooted in "man's labour" (Weber, 2002:12). Locke believed that private property comes from the natural right of mankind. Locke (1764:215) suggested that God created everything for human beings and "God, who hath given the world to men in common, hath also given them reason to make use of it to the best advantage of life and convenience" (Locke, 1764:216). Therefore, God also allows mankind to use everything that God provides for humans in common in order to support human being's lives and make their lives convenient and comfortable. Everything created by God is given to human beings in common, hence, nobody has an original right to put things created by God into his or her private domain. However, it is necessary for human beings to find methods to appropriate things given by God before making use of these things (Locke, 1764:216). Locke believed that although everything created by God belongs to human beings in common, "every man has a property in his own person: this no body has any right to but himself" (Locke, 1764:216), which meant that "the labour of his body, and the work of his hands, we may say, are properly his" (Locke, 1764:216). Therefore, every man who uses his labour to mix things created by God can be given private property in the things. He suggested that because the labour was the property of the labourer, no man but the labourer could have private property on things that the labourer used his labour to mix with, "at least where there is enough, and as good, left in common for others" (Locke, 1764:217). Thus, private property should have to follow these conditions. One condition was "enough and as good left for others" (Hettinger, 1989:44). This means Locke's theory opposed illogical "over-accumulation of personal

property, which would not be morally justified" and may infringe other's right (Richards, 2002:524). Hettinger (1989:44) summarised the other condition was that the private property should prevent waste. Thus, if a person uses more than one, which can lead to waste, then it should not be moral.

Based on Locke's property theory, Hughes (1988:3) made a justification for intellectual property. Hughes put forward three propositions for his justification of intellectual property upon Locke's theory. The first proposition was that "the production of ideas requires a person's labour" (Hughes, 1988:3). The second proposition was that "these ideas are appropriated from a 'common', which is not significantly devalued by the idea's removal" (Hughes, 1988:3). And the last proposition was that "ideas can be made property without breaching the non-waste condition" (Hughes, 1988:3). Hughes (1988) believed that many people accepted these propositions and intellectual labour should be given property rights in a similar manner to physical labourer who mixed their labour with things created by God.

2.3.2. Hegel's personhood theory of property

Georg Hegel brought forward a different property theory—"necessity of private property" theory (Richards, 2002:528). As summarised by Richards (2002:528), Hegel believed that humans were "essentially rational creatures". People need to develop the "capacity to participate in the ethical community", which is required by historical progress (Richards, 2002:528). For this reason, "people must develop personality, understood as a sense of their individual capacities and wills" (Richards, 2002:528). Hegel (2001:55) believed that human beings needed to develop themselves to create their personalities in historical progress. This self-development and creation of personalities are realized through the development of individual capabilities and wills. Hegel (2001:55) also considered that property rights helped to develop the individual's personality. He suggested that property rights satisfied human beings' basic needs. Property also becomes a medium through which the individual person can transit his

subjective personality to the objective world. Thus, "a person has the right to direct his will upon any object, as his real and positive end. The object thus becomes his" (Hegel, 2001:57). Hegel (2001:58) indicated that property ownership was the embodiment of human beings' will and the will of individual people was realized through the ownership of property. This is because that the will can change the object through an individual's labour and the change of object also influences human beings' wills. Human beings realize their self-development in individual capacities and wills through the changing of the objects given by the nature. Since will is realized differently by different individuals, the acknowledgement of will must be identified individually and property rights should be private. Therefore, property should give ownership according to human beings' labour. To Hegel, intellectual property was also an embodiment of personality. Intellectual property was similar to physical property, in that they both embodied the development of the individual capacity and wills of humankind.

2.3.3. The Utilitarian view on IPRs

The Utilitarian view of IPRs was based on the economic benefit for the whole society brought by IPRs legal regulations (Weber, 2002:6). This research does not intend to criticize Utilitarianism, but to introduce its arguments on IPRs regulations. To utilitarians, IPRs establishment, especially copyrights and patents, resulted from both the fact that "innovation and creation are good and necessary for the 'general happiness'" and the fact that without IPRs protection using "monetary incentives", innovations and creations would be created at very slow rate (Weber, 2002:6). This means that they believed that innovations were favourable and indispensable things for society and the establishment of IPRs protection in law could provide incentives for encouraging innovations. Moreover, they argued that IPRs protection could also support the presence of professional innovators and artists in the absence of patronage provided by "a ruler, wealthy merchant or even a modern corporation" (Weber, 2002:6). According to utilitarians, "utility maximization" was the guide to realize "efficient resource allocation" in a market system and IPRs provided "the necessary incentives for

the production of useful knowledge" (Richards, 2002:525).

The main disagreements on IPRs including TRIPS focus mainly on the impact of IPRs on economic development. Many countries, including developing countries, want to get benefits from the regulation of IPRs and these benefits mainly lie in obtaining more advantages and economic profits. Economic analysis of IPRs protection should be beneficial to discussions of the influence of IPRs protection on technology diffusion. Therefore, this section explores the Utilitarian view on IPRs in detail.

Utilitarians gave several reasons for establishing IPRs protection. Firstly, according to David (1993:24), there might be many problems in allocating resources for information and knowledge in competitive markets, because information and knowledge as commodities had some specific characteristics like "public goods". Societies have a certain specific need for technological information in a certain specific time, which requires information should be generated according to social need. Technological information and knowledge has the following characteristics. On one hand, information or knowledge is a kind of "nonrival good", which means that information or knowledge can be owned by and "enjoyed jointly by as many as" people who want to know and use it, and there is no conflict in owning and using information and knowledge among people (David, 1993:27). For a common commodity, such as a chair, one thing can be owned by only one person or one collective of people. If another person or another collective of people wants to own this chair, that other person or other collective of people must take some measures to eliminate the ownership of this chair by the original owner; otherwise there will be conflict about the ownership of this chair. However, in the Utilitarian view, if any one wanted to know and/or own information and/or knowledge, they could know and own the information without creating any conflict on the ownership of it. Significantly, the information commodity does not need to be invented or researched again, once this kind of information is acquired, because "information can be used again and again without exhausting it" (David, 1993:25). This means that in the Utilitarian view, after information and knowledge had been created,

there was no need to discover this information again to know or use it, and continuing to know and use the information would not deplete it. Meanwhile, once a kind of information has been disclosed, it will "force itself into the possession of every one" and no one needs to pay for it, which means it will cost nothing to obtain (David, 1993:26). This means that information has the nonexcludable attribute, that, without using some special measures such as keeping it secret, it is impossible to control information and knowledge for the exclusive ownership and use by a person or a collective of people once that information and knowledge has been discovered. Therefore, without the control by special measures, information itself will be automatically diffused among the whole society and persons who want to know and use the information, can know and use it without offering any payment. Certainly, an individual can keep his information in secret or using some forms of code to prevent that information from being disclosed (David, 1993:26). However, coding technologies are easy to penetrate and the cost of keeping information secret is quite high. This means that though there are some methods to keep information for the exclusive use by a person, keeping it secret is quite costly. With the characteristics of "public good"—"nonrival possession, low marginal cost of reproduction and distribution and substantial fixed costs of original production", the price of information and knowledge is prone to be quite low, which cannot give enough return to producers of information and knowledge (David, 1993:27). However, the fixed cost of creating original information is quite high. So, if creators of information cannot obtain enough return for their costs, they will not want to do R&D any more. The allocation of resources in competitive markets for creating information and knowledge will be inefficient. IPRs protection, which gives monopoly power for creators of technological information, is one of the methods that can ensure profits and return to owners of information, which can change inefficient allocation of resources to an efficient way. The second reason is that it is only through the diffusion and commercial use of information and knowledge that provides beneficial effects and improvements (David, 1993:24). Utilitarians believed that IPRs protection could promote the diffusion of knowledge and information into commercial production. They believed that because IPRs protection provided

exclusive protection for innovations and technologies for a period, owners of innovations and technologies would try to achieve commercial use within this period to earn profits which could promote opportunities for making that knowledge and information more widely diffused and improved. Without IPRs protection, utilitarians considered that owners of technological information would try to keep their information secret, which would prevent the diffusion of technological information. The last reason was that societies only needed useful inventions and information, but the creation of inventions and technological information did not follow the need of society. Sometimes there are some unusable technologies and information created in society. These unusable technologies and information will waste some resources and sources. IPRs protection can create incentives for producing useful innovations while preventing the appearance of useless innovations, because IPRs protection can use market power to evaluate each innovation (David, 1993:25). They believed that market power could encourage people to make useful innovations and prevent people from useless innovations because of the return from the market.

Although these reasons make some senses on IPRs establishment in economic aspects, utilitarians also put forward some problems aroused by IPRs. IPRs protection can produce deadweight burden problem which means social losses in establishing IPRs protection, because IPRs protection creates a temporary monopoly power for inventers giving exclusive possession and use of technological information (David, 1993:34). This problem has special relevance in patents. The monopoly power created by IPRs protection tends to work in two ways. On one side, “in the case of non-drastic innovations”, monopolists, who are given IPRs protection, especially patent protection on their innovations, have a greater incentive to keep their position of monopoly power by carrying through research and making further development of their innovations than potential entrants, because they can get high profits in further innovations by creating new monopoly positions and they want to maintain this advantage (Menell, 1999:137). Here, the “non-drastic innovations” are new innovations that can create new valuable profit for owners of old innovations through doing betterment based on old innovations.

Therefore, monopolists who own old innovations have more incentive to get these new non-drastic innovations. Under this situation, monopoly power is easily maintained. On the other side, "in the case of drastic innovation", monopolists cannot get much profit from their innovations as these innovations have already brought high benefits for monopolists and doing drastic innovations "may only displace all or part of the existing monopoly profits" (Menell, 1999:137). Here, drastic innovations are new innovations that can thoroughly replace old innovations, which can also create new profits that replace the profits brought by old innovations. Therefore, potential entrants may have greater incentive to do drastic innovations than current monopolists who own old innovations because new innovations would displace almost all profits created by old innovations, which creates new monopoly power in the market (Menell, 1999:137). In the latter situation, monopoly power has been continued, and the only difference is that it has been transferred from owners of old innovations to owners of new innovations. Thus, monopoly power will be created and continued in both ways. Under the conditions of better IPRs protection, monopolists will not worry about the appearance of potential entrants through copying, imitating, "inventing in reverse engineering", or "inventing around" existing innovations (David, 1993:34). And they may add additional price onto their innovative products "above the marginal costs of production and restrict output accordingly" and get royalty income from "final customers" (David, 1993:34), consumers have to pay higher price for the innovative productions based on IPRs protection (McCulloch, Winters and Cirera, 2002:210), and therefore, the benefits obtained by societies and consumers in using technological information and knowledge will be lower than that can be got in competitive markets (David, 1993:34). Here, reverse engineering means the process used to discover the technological principles of an invention through analysing its structure and operation. It is usually used to find core technologies of a kind of a device or system, in order to develop new devices and systems. Reverse engineering is a kind of method that used to discover technologies in innovations, which had been protected by IPRs, without paying royalty to or getting permission from IPRs holders. It is usually applied in pharmaceutical and software innovations. Secondly, some utilitarians also believed that IPRs could lead to the patent

race problem. Because IPRs give protection to the person who first invents innovations, there will be the result that this person will take all benefit brought by the protection. This is so called “winner takes all”, “or substantially all” (David, 1993:34). Scientists and inventors will contest in the races for discovering the innovation first, which is called the “patent race” (Menell, 1999:136). There are two different opinions on the “patent race”. Some people thought that it could create the acceleration in investment for R&D and stressed for keeping in advancement (Menell, 1999:138). This means that these people considered that “patent race” could boost the investment in innovations and research, which could push the inventors to keep the advanced position. Others thought that the patent race would produce overinvestment in R&D, which would induce inefficient allocation of resources (Menell, 1999:138). Thirdly, IPRs protection can create problems in intermediate information inputs. David (1993:27-28) summarised, knowledge had “cumulative and interactive” characteristics. Almost all kinds of scientific knowledge and technological information were generated through “increments, with each advance building on and sometimes altering the significance of previous findings in complicated and often unpredictable ways” (David, 1993:28). Innovations can also be improved to get new inventions through adding new ideas and new methods by someone, who may not be the creator of the original innovations. This means that most technological information is produced on the base of accumulated knowledge created by previous inventors. However, if previous research results, inventions and discoveries have been protected through IPRs protection, new researchers may need to pay royalties for obtaining previous inventions. Some of them cannot afford the royalty, which can result in slower developments in the research process. Moreover, many scientific problems and “economically significant researches” are needed to solve many different “interrelated problems” (David, 1993:35). Each solution for these interrelated problems can be entitled to a separate IPRs protection. Some researchers or companies have more advantages in resolving one or some parts of these problems than others. This implies that some researchers or companies can solve some parts of these problems more efficiently than others. Under these conditions, the lack of communications, cooperation and coordination among different competitors,

there will cause a problem in the intermediate information input into researches, which will lead to barriers for improving and developing inventions and researches (David, 1993:35). This means that without communication, cooperation and coordination, researchers and companies can only develop technologies or some parts of technology, in which they are more professional and more efficient than others. However, resolution of the final questions, which may involve all results of these different technologies and different parts of technologies, cannot be obtained without communications and cooperation among different researchers and companies. Hence, technology development will encounter negative impacts.

Based on discussions of the problems above, utilitarians had put forward some possible solutions. Firstly, some pointed out that changing the length and the breadth of IPRs could optimize the system and get optimal results, especially for patents (David, 1993:37). Secondly, some believed that forms of collaboration, sharing of patents, and compulsory licensing could solve the problem of intermediate informational input brought by IPRs protection (Menell, 1999:139-140). Finally, some suggested the use of other kinds of governmental methods as complements to solve problems created by IPRs protection. They believed that IPRs protection was not the only way to solve problems created by information having attributes of "public good". There were other methods that could help to deal with problems generated by public good: one was giving "producers publicly financed subsidies" and then requiring the goods to be free of charge to the public (David, 1993:27). This means that governments provided innovators with public subsidies to support their innovations and then required innovators to put their innovations into public domain and made them free to the public. The other was using state taxation to "finance its direct participation in production and distribution of the good, furnish and manage the requisite facilities and contract when necessary with private agents to carry out the work" (David, 1993:27). This method means that governments used state taxes to join the innovating and distribution of inventions directly and governments sometimes also signed contracts for innovation with private agents. They believed that using these two governmental methods as

complements could help to settle problems brought by IPRs protection.

2.4. Arguments against IPRs

Besides theories that support IPRs establishment, there were also some arguments against IPRs protection, especially on patent and copyrights. The Libertarian view strongly opposed the establishment of IPRs. The alternative arguments provided some valuable points and discussions on IPRs protection. These alternative arguments can be divided into two groups. The first group includes arguments which against intellectual monopoly completely and suggest that other systems should be created to generate incentives for innovation. The second group includes arguments that IPRs protection is still necessary but there should be some reforms and complements for the IPRs system in order to increase the benefits and reduce the costs created by the intellectual monopoly power.

2.4.1. The Libertarian view of IPRs

Many libertarians considered that all kinds of intellectual creations should be "freely accessible and utilised" by anyone who wants to get them (Gupta and Rastogi, 2002:4). They supported the idea that everything made by human beings "with their hand and/or with their own capital in collaboration with their creative mind was their exclusive property" (Gupta and Rastogi, 2002:4). However, they considered that these things should be sold under the condition of free competition and any extra regulations such as the establishment of IPRs are barriers for this system, which may prevent other people from develop these creations and bringing benefits (Gupta and Rastogi, 2002:4).

The Libertarian view on IPRs was based on four perspectives. Firstly, according to Kinsella (2001:19), libertarians "believe in property rights as tangible resources". This consideration is due to the scarcity attribute of tangible resources, which means that "there can be conflict over these goods by multiple human actors" (Kinsella, 2001:19-20). This implies that if tangible resources are owned by many people, there

will be conflict over the use of these resources. This is the scarcity character of tangible resources. Basic "social and ethical function of property rights" is bestowed on these tangible resources to prevent the conflict of using these resources by multiple human beings (Kinsella, 2001:19-20). This means that from the social and ethical angle, it is necessary to confirm property rights of tangible resources in order to avoid the occurrence of conflicts over their use. However, according to Kinsella (2001), ideas, which were the main components of intellectual creations, did not have the attribute of scarcity. This means there is no conflict in using an idea. Kinsella considered if A had an idea, B or C or any other person who used the idea would not affect A's using the idea. Thus, Kinsella thought there was no need to make intellectual idea exclusive (Kinsella, 2001:22). Kinsella believed that the scarcity of ideas generated by IPRs protection was not a natural scarcity (Kinsella, 2001:24) and it was unjust to establish IPRs protection. However, one can question the logic of this point. Libertarians use the criteria which are applied to establish property rights over tangible resources to evaluate IPRs. This is inappropriate because intangible resources, such as ideas, have different attributes. Tangible resources, such as houses, can be only owned by one or joint owner. Ideas can be known by anyone, which means that ideas can be owned by many owners who know the ideas. Because there is no tangible objective for ideas, anyone who knows the idea may be considered as the owner of it. However, not all persons, who know the idea, are true owners of the idea. The true owners of ideas are the creators of ideas, who put manpower and material resources into R&D to get ideas, or the buyers of ideas, who pay a lot of money to obtain ideas from the creators. The contribution of true owners should be respected. Persons who know ideas without any contribution or with only very limited contribution, should receive different treatment from the owners of ideas. So, although ideas do not have scarcity attribute, it is still necessary to distinguish the true owners of ideas. With different characteristics, it is inappropriate to use the criteria that applied in tangible resources to evaluate intangible ideas. Secondly, Kinsella (2001) believed that "property borders and property rights must be objective" and visible in order to let individuals prevent using others using their property (Kinsella, 2001:20). Moreover, property rights must also be just. This means that property rights must follow

the principle that the first occupier or user owns the resource (Kinsella, 2001:20-21). Kinsella summarised, that only if individuals accepted that the property rights were ruled fairly, could property rights be implemented and the function of avoiding conflict on using tangible resources be realized (Kinsella, 2001:20). Nevertheless, ideas do not have objective character. The property of ideas will not be shown clearly, because they cannot be identified without an objective. Creations make ideas to be loaded on tangible resources (Kinsella, 2001:21). The loading of ideas on tangible resources destroys the principle that the first occupier or user owns the tangible resources, because it creates a new principle for the ownership of tangible resources—the use of creative ideas (Kinsella, 2001:27-28). For an example, a person creates a useful idea. This idea can guide a user to use his or her own tangible property. If the innovator gets IPRs protection for the idea, he or she can have the right to control other persons' use of his or her idea. Other persons, who own the same tangible property as the creator, cannot use their tangible property in the same way as the idea creator. The ownership of tangible property is partly controlled by the idea creator. Creating ideas then becomes a new principle for the ownership of tangible property. Using the example given by Kinsella (2001), A has a new idea to build his cabin on his land using his own materials. Other persons see it, but cannot build their cabins on their own lands using their own materials in the same way as A, because A created the idea of building cabins and the idea has been protected through IPRs to prevent others from using the idea without A's permission. Thus, giving ideas the IPRs protection is unjust. However, one can say that giving IPRs protection to idea creator does not create a new principle to own tangible property. Providing IPRs protection to idea creator just restricts some part of usufruct of the tangible property owners rather than replacing others ownership over tangible property. IPRs protection prevents other persons using their own tangible properties in the same way as the idea creator. The owners of tangible properties can still use their tangible properties in other ways. Moreover, the creative ideas will not be as simple as Kinsella's example—building a cabin. Ideas will have some quite creative factors, which mean that they cannot be found out easily. Without knowing the ideas, it is certain that other people cannot use their materials in the same way as those who own

the ideas. Even if creators of ideas want to talk about their creative innovations to others, they are worthy of respect as the creators of ideas and being rewarded, because they make progress and benefit others. Thirdly, libertarians believed that even if there was a need to prevent free copying and imitating of innovations, the market would find better methods to do it (Gupta and Rastogi, 2002:5). It means that the market will push creators of innovation to produce other things to prevent free copying and imitating, such as using coding techniques to prevent the copying of software (Gupta and Rastogi, 2002:5). This means that under market power, human beings can produce technologies to prevent free use of innovations. However, one can say that, as protective measures improve, so do skills for copying and imitation. The strength of the free market may not help to push the creators of innovations to develop enough anti-copying technologies. We need to find other methods to protect innovations such as using IPRs for protection (Gupta and Rastogi, 2002:5). Finally, libertarians believed that scientific development was a continuous process (Gupta and Rastogi, 2002:5). This means that nowadays, any person's creations are based on his predecessors' creative ideas and creations. The fact that just giving IPRs protection to the last person while neglecting his predecessors' ideas and creations is quite unfair (Gupta and Rastogi, 2002:5). However, one can say that IPRs just provide protection for the creative parts made by innovative creators rather than others' ideas applied in the innovation. For an example, if A obtains a patent for his innovation and B improved on A's innovation, B can then obtain a patent for the improvements. Moreover, the patent granted to B does not replace A's patent. In addition, although most scientific and technological developments are continuous, many innovative creations push the development process forward faster than ever. These scienctific and technological developments can be used by many people, but not many of these people can invent new creations based upon these sciences and technologies. Persons who create inventions, do not bring slow and simple improvements on sciences and technologies but rather, they accelerate the development of science and technology. These persons' creations should be respected and rewarded.

2.4.2. Arguments against IPRs protection

In general, arguments against IPRs protection were based on harmful effects of monopoly power caused by IPRs. These arguments argued that the adverse effects of the monopoly power in the market created by IPRs protection exceeded the benefits of creating incentives for innovations and consequent benefits for social welfare. Some researchers believed that there were other methods that could generate incentives for inventions without creating the social losses caused by the monopoly control of IPRs.

Boldrin and Levine (2005) considered that IPRs could be classified into two parts. The first one is the right for sale, which endows innovator or any other rightful owner of a copy of an idea or an innovation the right to sell it to another party. The second part is the intellectual monopoly, which means that the owner of an intellectual property has the right to control and restrict how buyers utilize his or her idea or innovation after these buyers gain the idea or innovation through legal methods because IPRs provide the innovations owner with a monopoly power over the use of the innovation and avoiding others making use of this intellectual property to realize keeping the enjoyable right of intellectual property to right holders exclusively (Boldrin and Levine, 2005:8). The owners of other goods except ideas all have the right for sale but do not have any intellectual monopoly. That is the owners of other goods except ideas have the right to sell their goods to another party, but do not have the right to control and restrict how buyers utilize their goods after buyers obtain the goods through legal methods. However, IPRs protection provides the owners of innovations and ideas with both the right of sale and the intellectual monopoly. Boldrine and Levine (2005) gave an example to illustrate the difference between right held by the owners of ideas and the right held by the owner of other goods. If a person buys a potato, the person can then eat it, throw it away, plant the potato, or make the potato into a sculpture. The person, who brought the potato, can also “use the idea of a potato embodied in it to make better potatoes or to invent French fries” (Boldrin and Levine, 2005:9). However, according to IPRs protection, if a person brought a CD, a book, a kind of computer software, and medical drugs, the person

cannot have the freedom to do invention based on the ideas embodied in the CD, book, software and medical drugs. Boldrin and Levine supported the right of sale. They believed that it was important to let the producers of intellectual property be able to profit from their innovations through exercising the right of sale (Boldrin and Levine, 2005:7). However, they were against the second part of IPRs—the intellectual monopoly (Boldrin and Levine, 2005:8-9). Although there was some social benefit brought about by the monopoly, they argued that it generated "many social costs" (Boldrin and Levine, 2005:9). They thought that monopoly power had the function of pushing wealth from the majority of people who did not have the monopoly power, to the minority of people who did. They also used the example of James Watt and his invention—steam engine—to explain that the monopoly power given to Watt prevented technological improvement in this area. Just after the expiry of Watt's patent, the steam engine improved dramatically (Boldrin and Levine, 2005:1-4). They considered that the original inventor had the "natural first-mover advantage" over the others, because the original inventor was the only one that knows the idea and how to use it (Boldrin and Levine, 2005:8). They believed ideas were scarce. The original inventor can take the first-mover advantage and the scarcity of the idea to acquire profit. They showed that Watt and his invention embodied strong first-mover advantage. After many years of Watt's invention and after many competitors obtained Watt's invention through reverse engineering, Watt still had substantial market power (Boldrin and Levine, 2005:8). They believed that there was no need to create a monopoly power to provide incentives for innovation and intellectual monopoly prohibited the creation of innovations and social prosperity growth (Boldrin and Levine, 2005:6). However, one can question Boldrin and Levine's explanation. With the rapid development of science and technology, new ideas and technologies are easily copied in a short time with very cheap methods. The original innovator may not have very strong first-mover advantages in some areas, such as computer software, because his or her innovation can be copied quickly at a very low cost. Without IPRs protection, no one wants to buy ideas or technologies from original inventors, if they can copy the ideas or technologies cheaply. Therefore, without IPRs protection, which provides intellectual monopoly power to prevent imitation from

others, the right of sale cannot be exercised by innovators, and they cannot get rewards to cover their expenses in doing the R&D using the right of sale.

Fisher (2004) put forward an alternative incentive system for copyrights, especially for entertainment. Fisher noticed that ideas had the nature of public goods—nonrivalrous and nonexcludable characteristic, and there should policies to resolve problems caused by this kind of goods (Fisher, 2004:1-2). However, he believed that the current copyrights system and other governmental control systems had many disadvantages, so he proposed a "governmentally administered reward system" (Fisher, 2004:1-3). This system lets all creators who want to get a return from their songs or films, register in the Copyright Office. The file name created through registration will be "used to track transmissions of digital copies" of their works (Fisher, 2004:3-4). The government will provide enough money, which can be obtained through taxation, to compensate registrants for their costs in creating their works and then the government will put their works into the public domain to permit free use of them (Fisher, 2004:3-4). Government agencies can reckon the hearing or watching frequency of each works by consumers through "techniques pioneered by American and European performing rights organization and television rating services" and then give every registrant periodical payments through "a share of the tax revenues proportional to the relative popularity of his or her creation" (Fisher, 2004:3-4). Fisher believed that this system could make the public pay less for entertainments because most songs and films would be free of charge for the public and creators of songs and films could also gain sufficient compensation through this system (Fisher, 2004:4). Fisher pointed out advantages and disadvantages of this system. This system can bring benefits for consumers with cost savings and easy access to all kinds of entertainment; for creators of songs and films with reliable incomes and greater sources for further creations; for producers of electronic equipment with more "demand for their products"; and for whole societies with cost savings in "enforcing copyright law" and dealing with lawbreaking (Fisher, 2004:41). However, there are also disadvantages of this system, which include "cross-subsidies and associated distortions of consumers' behaviour", "erosion of artists' ability to control the

public presentations of their works", difficulties in "administrative discretion and rent-seeking" and "leakage across national boundaries" (Fisher, 2004:41-42). Fisher thought that although this system was not quite perfect, comparison with other systems and the benefits as well as disadvantages, showed that it was a better alternative to the copyright system.

Wright (1983) suggested that a prize system was a better incentive system for innovations. He developed different economic models to examine three different invention incentive systems—patents, prizes and research contracts. He concluded that the reason for the patent system being better than a prize system was that the patent system "incorporates 'the value of successful inventions' in the 'allocative process researchers' information " (Wright, 1983:704). Wright believed that the patent system was better than a prize system because the patent system used the benefit of successful innovations to balance and distribute resources, researchers and information. Only successful innovations can be given patent rights, and a patent system can also use market power to evaluate the usefulness and value of an innovation. The information that an innovation can be successful, whether it can be useful and its value, cannot be obtained easily in a prize system; therefore, a patent system is better than a prize system. However, he pointed that a patent system was not always the best incentive system for innovations and proposes that if governments could hold the necessary and enough information about the innovations and the markets, a prize system could be better than a patent system.

Baker (2005:1) considered that IPRs protection, especially copyright and patent, was a kind of "government intervention in the market", which could not have a positive impact on innovative activities in the new century. The monopoly power created by IPRs protection policy caused the protected software to be sold at prices that are far higher than the prices in a competitive market. Software should be available for the public "at zero cost" through the Internet, without the protection of copyright and patent (Baker, 2005:1). Baker (2005) believed that products should be sold at their marginal

costs, which could maximize the efficiency of the economy. However, the aim of copyright and patent protection is not to keep marginal-cost pricing, but to charge prices much higher than those in a competitive market through use of their monopoly power by the holders of copyrights and patents (Baker, 2005:3). Baker (2005:3) pointed out that IPRs protection on software could induce "deadweight efficiency loss". IPRs protection on software has created great social loss compared with prices of software in free market (Baker, 2005:1). IPRs protection can also encumber the development of software, because researchers cannot make improvement freely to protected software. IPRs protection also produces unnecessary duplication, because researchers have great incentive to develop software that just duplicates "the function of existing software" (Baker, 2005:1-3). IPRs protection also results in great waste, such as "expenditures for advertising and marketing, and payments to lawyers and lobbyists" (Baker, 2005:1-3). The waste expenditure also involves "efforts to monitor the distribution of software over the web, legal fees associated with enforcing IPRs and contributions to political campaigns and public relations efforts needed to sustain and extend IPRs protection" (Baker, 2005:11). Baker (2005) put forward two alternative methods to encourage software development. One is to create a "software development corps", which means several software corporations funded by governments (Baker, 2005:13-14). The software developed under this system should be free for the public. This system is also designed to incorporate enough competitive factors through dividing the public funding into several "competitive public corporations" and to provide sufficient monetary incentives for software developers (Baker, 2005:13-14). Baker (2005) believed that the money invested the in software development corps could easily be compensated through reducing expenditure on purchasing software. Another alternative system is the "Artistic Freedom Voucher", which means that the government provides every adult with a certain amount of money to be used to support any person who is engaged in innovative or artistic work, including developing software (Baker, 2005:15). The person who receives the voucher must "register with the government" to "obtain non-profit status" and accept supervision by the government (Baker, 2005:15). All works created in this system will be free for the public. Baker (2005) believed that these two alternative

systems were feasible and better than the current IPRs protection system in encouraging software development.

2.4.3. Arguments about reforming the IPRs system

Although many arguments address to the costs of the IPRs system, some researchers believed that the IPRs system was quite useful and even indispensable. They considered that it was preferable to reform the IPRs system to increase its benefits to society and mitigate its costs and harmful effects.

Davis (2002:2-3) proposed to use an ex ante R&D "grand prize" system to provide incentives for basic research. Davis noticed that with the development of a patent system, research results had increasingly turned toward patent and the amount of freely used knowledge available to the public had decreased (Davis, 2002:2). Davis pointed out that the USA government funded many research projects, such as agricultural research, and then put the results into the public domain in the early twentieth century. From the late twentieth century, the USA government has reduced its funding of public and basic knowledge and researchers had turned to patents to protect their research results (Davis, 2002:4). Davis summarised that "fully 73% of private patents were based on publicly generated knowledge from university, government and non-profit laboratories" (Davis, 2002:7). Private firms could get benefits from public research through "publications, conferences, information channels and publishing" (Davis, 2002:7). Moreover, with the spread of patents, university scientists have became more willing to protect their results by using patents. The government funded innovations can have "socially negative effects" resulted from the fact that basic knowledge cannot be "freely available" to the public (Davis, 2002:6-7). Davis explained that an ex ante R&D "grand prize" system could be applied as a supplement to keep a patent's benefits while lessening its costs, especially in the decrease of public knowledge (Davis, 2002:2). The "'grand prize' R&D incentive system", in his view, was the system that "one party defines a problem to be solved and posts a reward for the best solution, typically a large

monetary reward" (Davis, 2002:3). Here the party that puts forward a problem and gives reward for its solution is usually a government agency, but sometimes can be "a firm, a foundation" or "a wealthy individual" (Davis, 2002:3). These parties, including government agencies, firms, foundations, and wealthy individuals mostly start from public interests and are "not ruled by profit and loss criteria" (Davis, 2002:4). Davis argued that the prize system could create incentives to do R&D to resolve medical and socially important problems, such as serious diseases in small groups. There is not enough motivation to solve these problems under the patent system, because the research results in these problems cannot create much profit. Davis also mentioned the benefits of the prize system. Firstly, "winning inventions do not have to be technical, they might also be organisational" (Davis, 2002:16). This means that the result of winning inventions in a prize system can be unpatentable. In patent system, if an inventor wants to use a patent to protect his or her invention, the invention must reach the following criteria: "novelty, non-obviousness, industrial utility" (Davis, 2002:7). However, not all inventions can fulfil these requirements. The prize system does not require inventions to fulfil these requirements. Inventions that cannot be protected by patent can still get prize. Secondly, prize system can also help to deal with social problems, such as pollution and welfare problems, which may lack incentives under a patent system due to the difficulty in making a profitable price in the market (Davis, 2002:16). Thirdly, there are many uncertainties in doing basic research and obtaining commercial use of the results, because sometimes the research does not obtain sufficient improvement to be commercially attractive in a suitable short period. This leads to under-investment in basic research. The prize system can encourage basic research despite great uncertainties. Finally, the prize system can also increase technological development because it can put innovations and knowledge into the public domain and let the public use the knowledge freely. However, Davis also pointed out that prize system might have difficulty in determining who should receive the prize and the amount of the prize (Davis, 2002:17). Because the prize system includes "administrative intervention in the market", it might also "divert inventive resources from more productive uses" (Davis, 2002:17). Moreover, because entrants cannot know completely

about each other's work, or entrants may be quite convinced that their results can win, resource duplication may occur (Davis, 2002:18). In general, in a comparison of the benefits and costs of the 'grand prize' R&D incentive system, Davis believed that the prize system had more advantages than disadvantages. However, one can question whether, if an innovation has been created under the prize system and put into public domain, with rapid transmission, it will be distributed worldwide. If so many countries without doing any efforts on this innovation will enjoy the new knowledge freely, which is quite unfair on the government agency that provided the prize for the innovation. Creating an international organisation to replace individual government agencies to apply the grand prize' R&D incentive system maybe a solution to this problem.

Thurow (1997) believed that although it was significant and essential to establish a IPRs system and a unitary and simple system had powerful virtues, a uniform size of IPRs system could not fit all types of innovations in different industries and conditions. Thurow sought to build a new system to "reconcile a number of competing interests and allow for some critical distinctions" (Thurow, 1997:102). Thurow believed that some kinds of knowledge should be accessible by the public freely, including knowledge that was relevant to the public interest and social welfare as well as some fundamental knowledge. For examples, basic academic knowledge and scientific information, knowledge that can help to educate new generations, and knowledge to keep people healthy and living longer should be put into the public domain. However, it is quite difficult to decide what knowledge should be put into the public domain and which can be kept privately. Thus, it is necessary to create some public agencies to explore what knowledge should be freely available to the public and then buy it and put it into public domain. Thurow also considered that the world should have a global IPRs system. However, this system should not be like the current TRIPS. A global IPRs system should take the differences in economic development, basic human needs and technological improvement between developed countries and developing countries into account. He also proposed that there should be different types of patents for different industries, different kinds of knowledge and different types of innovators.

Kermer (1998) recognized that a patent system could generate "static distortions, underinvestment in research and distortion of research toward duplicating existing inventions" (Kermer, 1998:1140-1143). Kermer drew a method of patent buyouts as a complement for IPRs system to mitigate the costs aroused by the intellectual monopoly from the practice of "The French government's purchasing the Daguerreotype patent and placing it in the public domain" in 1839 (Kermer, 1998:1137). The patent buyouts method means that governments buy "patents at their estimated private value, as determined in an auction with a mark-up equal to the typical ratio of the inventions' social and private value", and then most purchased patents will be put into "the public domain" but some will "be sold to the highest bidder to induce bidders to reveal their valuations" (Kermer, 1998:1137). In this system, patent holders can decide whether to sell their patent to governments or not, so this system is a supplement system for IPRs system. This method can reduce the "monopoly price distortions", mitigating "incentives for rent-stealing duplicative research" and "reverse engineering" aroused by the patent system and enhancing innovative "incentives for original research" (Kermer, 1998:1137-1138). Kermer mentioned that the main problematic factor of the patent buyout system was to decide the price of patents, and this difficulty could be resolved through an auction (Kermer, 1998:1138).

Shavell and Ypersele (2001) recognized that there were two kinds of basic methods to induce inventions. One is a reward system employed by governments, which can make innovations freely accessible to the public immediately after providing rewards for innovators; the other one is the intellectual property rights system, which endows "exclusive rights" to creators under governmental regulations and generates innovative incentives through providing intellectual monopolies for innovative products (Shavell and Ypersele, 2001:525). They synchronously noticed the problems of each method: reward method had difficulties in getting information for accounting the amount of the reward; the intellectual property system, especially the patent system could do harm for customers by causing "high prices" and might prevent further innovations if the holders of current patent did not agree to use their innovations (Shavell and Ypersele, 2001:526).

At the same time, they made a comparison between the reward system and the intellectual property system, particularly the patent system, and found that these two systems both had advantages superior to the other and disadvantages inferior to the other (Shavell and Ypersele, 2001:529-530). A patent system can bring a deadweight loss for social welfare and may also create less incentive for innovations "because monopoly profits are less than the social surplus" brought by the innovations (Shavell and Ypersele, 2001:529). However, a patent system has advantages in the fact that creators always may hold better private information about the value of the innovations than governments in deciding the amount of the rewards. Meanwhile, a reward system is superior to patent system because reward system cannot create deadweight loss for societies; innovative productions are sold at "marginal cost" (Shavell and Ypersele, 2001:529-530). But a reward system may also produce problems in generating incentives for inventions. Therefore, they proposed an optional reward system, which meant that innovators could select between a patent and a reward under this system. Moreover, in this optional system, governments can calculate the amount of rewards according to the volume of sales and ex post data (Shavell and Ypersele, 2001:531, 541). They used economic model to analyze this system and make comparisons with patent and reward systems. They concluded that the optional reward system was superior to both the patent system and the reward system because if innovators selected the reward, it would superior to a patent system because there was no deadweight loss and since "patent system may be superior to reward" "and whenever the patent system was superior to the reward the optional reward system must be superior to reward" (Shavell and Ypersele, 2001:539). However, one may think this optional reward system will only add reward as another option with an intellectual property rights system and the choice between reward and patent depends on the innovators. Innovators may select reward or patent according to which one can bring the most benefit for them and their selection may also be decided by other arbitrary factors. Moreover, once the selection has been decided, either patent or reward, the problems of patent and reward system still exist in each innovation. Therefore, this optional system may not have the ideal result intended for it.

2.5. Conclusion

To conclude, this Chapter introduces the brief history of integrating IPRs protection into the WTO system and formed TRIPS. More importantly, this chapter introduces the three main theories—Locke's "labour theory of property" (Hughes, 1988), Hegel's "necessity of private property" theory (Richards, 2002:528) and the Utilitarian view, which justified IPRs establishment. Moreover, based on the current situation—many disagreements on IPRs protection have great bearings on economic development and profits; this chapter presents the Utilitarian view in detail. It also explores the Libertarian view on IPRs. In general, the Libertarians opposed formal IPRs. However, according to analyses, the libertarian view on IPRs was quite weak. Then this chapter analyses some alternative arguments on IPRs protection. These arguments can be divided into two groups: arguments that are against intellectual property and arguments that suggest reform of the IPRs system. The historical review of IPRs integration into the WTO provides information on the background of establishing a global IPRs system, which is helpful for understanding the impact of IPRs on technology diffusion, especially in developing countries. IPRs theories and alternative arguments are also instructive for analysing a IPRs system and its impact for creating innovative incentive and technology diffusion for this research.

Chapter 3

Arguments related to IPRs protection and technology diffusion

3.1. Introduction

Science and technology is one of the most significant resources promoting productivity and peoples' living standard. Technology development and diffusion play important roles in the economic development of a country. Countries try to make the most favourable policies to improve their technology development and diffusion. TRIPS agreement, the aim of which is to encourage technology development and promote technology transfer, has become the most powerful international IPRs protection system under the WTO (WTO, 2006b). According to the WTO, each member state must accept TRIPS. Accepting TRIPS means the level of IPRs protection for many countries is enhanced, particularly in the developing countries and the least developed countries, because these countries have no or very limited IPRs protection. However, there are different opinions and heated debates about whether IPRs protection or stronger IPRs protection can bring benefits for technology diffusion for a country. This Chapter introduces and analyses different arguments related to IPRs protection and its impacts on technology diffusion.

There are some points, which need to be indicated in advance.

First of all, although there are different subcategories in the current IPRs protection system, two of them arouse particular debate. These are patents and copyrights, which are highly relevant to technology diffusion. This chapter concentrates on patents and copyrights and their relation to technology diffusion.

Secondly, the analysis of the relationship between IPRs protection and technology diffusion in this chapter is carried out at country level rather than at world level. It explores whether present IPRs protection or stronger IPRs protection can bring benefits for technology diffusion in different kinds of countries, such as developed countries or developing countries. The reasons for this arrangement are as followings: 1. The relationship between IPRs protection and technology diffusion is quite different among different countries, especially between developing countries and developed countries, because at present developed countries are the main producers of advanced technology while developing countries are main acceptors of technology. It is important to investigate the impact of IPRs protection on different kinds of countries, rather than to see it on the world as a whole by ignoring the differences among countries. 2. Analysing the different arguments from a country's perspective also helps to analyse the impact of the stronger IPRs protection obtained from WTO accession on technology diffusion for a specific country, such as China. This research also concentrates on the impact of IPRs protection on technology diffusion for a specific country, so, the analyses of different arguments related to IPRs' impact on technology diffusion for a specific country are instructive for this research.

Thirdly, technology diffusion is the process of disseminating technological information and subsequently adopting new technology and techniques by the users. Technology diffusion is a component in the broader innovation process (Queensland Government, 2006). This implies that technology diffusion includes two main parts, which are the development of new technology and the dissemination of technological knowledge. According to the WTO, the main aims of TRIPS are to create incentives for innovations to promote technological development and to encourage technology transfer (WTO, 2006b). Therefore, technology diffusion in any country should be divided into two parts: domestic technology development and technology transfer from foreign countries, which, sometimes correlate with each other. The development of technology transfer from foreign countries gives impetus, technological resource and information to improve domestic technology development. Domestic technology development

reinforces the ability of technological absorption for a country from foreign countries. Moreover, a country's domestic technology development may also attract foreign technology producers to invest in that country, and help to obtain more successful technology transfer from foreign countries.

Finally, present IPRs protection or stronger IPRs protection is not the only factor that can affect technology diffusion in a country. Other important factors, such as economic policies, political policies and foreign investment policies of that country have direct or indirect correlation with technology diffusion both in—domestic technology development and technology transfer from foreign countries. Sometimes, the impact of the present IPRs protection or stronger IPRs protection on technology diffusion comes from the collaborative effects of the IPRs protection policy together with other factors. Thus, in this chapter, these are also explored.

3.2. IPRs protection and domestic technology development

For a country, IPRs protection, particularly for patents, is mostly considered as a method of encouraging innovations, as mentioned in the description of TRIPS—IPRs protection can encourage invention and innovation in the long run (WTO, 2006b). However, as for whether IPRs protection can encourage domestic inventions, there are different opinions. Some contended that IPRs protection improved domestic technology development, others believed that IPRs protection inhibited further domestic innovations and suggested implementing weak IPRs protection, and yet others thought that the influence of IPRs protection on domestic innovation varied according to other relevant factors and the effect of IPRs protection under different conditions should be considered. This part analyses these different opinions about the influence of IPRs protection on domestic innovations development. Some IPRs theories containing arguments about the relations between IPRs and domestic innovation development have been analysed in chapter two, hence, this chapter only explores some specific opinions on IPRs and domestic innovation development.

Some researchers believed that IPRs protection encouraged innovation. One important argument, that IPRs protection encouraged domestic innovation in any conditions, was put forward by Kanwar and Evenson (2003). They did empirical research on the relationship between IPRs protection and innovation as well as technological change using cross-country panel data on R&D investment, patent protection and other country-specific characteristics during the period of 1981-1995. They found that IPRs protection had evidently positive and important influences on technological change. But, Falvey and Foster (2006) believed that this research had a limitation. In Kanwar and Evenson's research, the strength of IPRs protection was denoted "by an index of patent rights", and the "technological change" was shown through "R&D investment expenditures". Falvey and Foster (2006) pointed that although data of "R&D investment expenditures" could be seen as the leading input of innovative action and increases in this aspect could demonstrate increases of input for innovations. This data was problematical, as it could not allow for the risky characteristics of innovative activities (Falvey and Foster, 2006:24). Since not all innovative activities lead to successful innovations, an increase in R&D expenditure does not necessarily show an exactly increase in innovations. However, one can put forward some criticisms of Falvey and Foster's argument. The research done by Kanwar and Evenson (2003) showed that IPRs protection encouraged "R&D investment expenditures". The fact that IPRs protection boosts investment in R&D is the point that has a real relationship to the impact of IPRs on technology development. Whether the investment in R&D can lead to new technologies or not is irrelevant to the debate on the impact of IPRs on technology development. If IPRs protection can promote more investments in R&D, it shows that IPRs protection has positive influence on technology development, because normally when there are more investments into R&D, more innovations can be expected. It is true that the expenditure on R&D indeed cannot show the exact technology development. There are two reasons for this: one is that research is risky. Not all R&D leads to successful results, and another reason is that some innovative activities are repeated or useless. Many different researchers may do similar research, but only one of them will get a patent for the research result, other researchers' innovative activities are repeated

and the resources put into similar R&D would appear to be wasted. However, since research is risky, more investment in R&D means more likelihood of producing new innovations. Thus, if IPRs protection can bring more investment for R&D, then it indicates that IPRs protection has a positive impact on technology development.

In contrast to arguments that IPRs can encourage innovations, some researchers believed that present IPRs protection or stronger IPRs protection inhibited domestic technology development.

1) As Kanwar and Evenson (2003) summarised, Roffe pointed out that IPRs protection, especially patent rights, could lead to patent abuse in developing countries. The most common form of patent abuse in developing countries was “inadequate disclosure” in the patent, which meant that there were no significant “bits of knowledge” in the application of patent (Kanwar and Evenson, 2003:237). It is necessary for a patent applicant to disclose all important knowledge about innovation in application form, so that this kind of innovation can be diffused after patent is expired. A patent, especially the monopoly power given by a patent for a certain period, is the compensation for disclosing important information about the innovation, which makes it balance. However, inadequate disclosure of patent information breaks the balance. Technology holders want to get patents for their innovations so that they can get monopoly powers to prevent others from using their innovations for production. With this monopoly power, technology holders can ask high prices for products containing their patented innovations. Meanwhile, in order to prolong the time of their monopoly power, technology holders try to avoid disclosing their core technology in their patent application form. Without significant knowledge about the innovation, even very skilled people in the relevant discipline cannot replicate the innovation after the patent duration has expired (Kanwar and Evenson, 2003:237). This leads to the technology being unusable and copied even after patent expires. However, one can argue that if the patent application does not disclose enough information about the technology, there will be a risk for the patent applicant that others can reverse-engineer this technology and claim

ownership of the innovation by providing more information. According to the current IPRs policy, a patent can only be given to innovations which achieve certain requirements. These requirements are novelty, non-obviousness and industrial utility. Moreover, patents can only be given to one applicant. If an innovation has been given a patent, similar innovations cannot get patents because they cannot reach the novelty requirement. Thus, even if a previous patent holder did not reveal enough information in its patent applications and others get the innovation through reverse-engineering, they cannot claim the ownership of the innovation through providing more information, because it is not novel. One can also put forward that a patent gives an innovation up to 20 years protection, which is almost for its entire life-time. By the end of 20 years, there will most likely to be a newer invention to replace the original innovation. Even if there is not enough information disclosed for the original innovation, the original innovation is no longer useful. The inadequate disclosure of patent information does not have an impact on technology development. However, 20 years is not a life-time for all kinds of innovations, and some have life-times that are longer than 20 years. If the original innovation is still useful and important by the end of 20 years, the inadequate disclosure of patent information will restrict others using the innovation freely. One may also argue that inadequate disclosure of patent information is just a side effect of IPRs system and does not have relation with encouraging new innovations. However, it has been used by patent applicants to prevent their innovations from being used even after their protection period expires, and has turned out to be a limitation of the current IPRs system. With the limitation of inadequate disclosure of patent information, IPRs protection may prevent technology development.

2) Lerner (2002:27) evaluated the influence on inventions by the patent protection system by examining the change of the strength of the patent system “across sixty countries” over a period of 150 years. Lerner found that the reinforcement of patent protection system had very few positive impacts on applications for patents by domestic entities in the country that was adopting the policy of strengthening patent protection system through investigating “177 policy changes” (Lerner 2002:27). This means that

Lerner obtained the conclusion that stronger patent protection could only bring very few encouragements on patent applications in countries that tried to reinforce their patent protection. Patent application is an important indicator for technology development in a country. More patent application in a country means that there is more technology available in a country. Therefore, the result gained by Lerner's research also showed that stronger IPRs protection had very little positive impact on encouraging domestic technology development in countries that were trying to implement stronger IPRs protection.

3) Branstetter Fisman and Foley (2005) explored the impact on technology transfer among the USA multinational companies by a series of reforms on IPRs protection carried through by 12 countries in the period of 1982-1999. This research also showed the change of patent filings by non-residents and by residents during the period of IPRs protection reform. They found that by comparison with a "pre-reform period", there was no obvious growth in patenting by domestic residents after the reform on IPRs protection (Branstetter, Fisman and Foley, 2005:24-25).

4) Helpman (1993) also argued against stronger IPRs protection. He pointed out that stronger IPRs protection could only raise the "rate of innovation" in the short-term because stronger IPRs protection could enhance the profitability of innovations. However, in the long-term, stronger IPRs protection induced a decrease in the rate of innovation because the owners of IPRs had the tendency to produce productions using the older technology.

5) Harison (2008:60-62) believed that in most cases, innovators could not obtain a new technology in a void, but through gradual improvements based on previous innovations, so the dissemination of knowledge was the most important way to promote new technological development. However, he drew his conclusion from empirical evidence that IPRs protection, especially patent protection, was widely applied for strategic commercial reasons, such as preventing other rivals from entering the market by using the new technology and demanding extra royalties for new innovations, rather than to

encourage the development of new innovations. This means that in the view of Harison, IPRs protection, especially patent protection, was generally used as legal means to hinder competitors from commercial use of new technology. From this point, IPRs protection had little positive impact on technology development.

6) Gilbert and Newbery (1982:514) argued that strong IPRs protection, which produced monopolies, could result in accumulating "sleeping patent" by producers in order to conserve market share. According to Gilbert and Newbery (1982), a "sleeping patent" was "an invention that was not put to commercial use" (Gilbert and Newbery, 1982:517). This kind of patented technology is not used for commercial production nor is it licensed to other people who want to use it (Gilbert and Newbery, 1982:514). This means that owners of innovations want to obtain patents for their innovations, but have no intentions of using their innovations for commercial production for profits and market conditions. This action comes from a desire to keep their monopoly power by patenting a kind of new technology based on their old patented technology before other potential rivals (Gilbert and Newbery, 1982:514). The result for a "sleeping patent" is that the time for people to obtain innovative production is prolonged. And the time that other researchers, who want to do research based on such a patent, is also prolonged. Therefore, diffusion of this kind of technology is delayed. Gilbert and Newbery (1982) also indicated that with monopoly power created by IPRs protection especially by patent, a firm "had an incentive" to preserve the "monopoly power" through getting patents for new innovations before potential rivals, which resulted in that existing patents not being "used or licensed to others" (Gilbert and Newbery, 1982:514). Resources may be used to produce innovations in order to preserve a firm's monopoly market power without distributing new technology. In this sense IPRs protection does not encourage domestic innovation. However, the negative impact of "sleeping patent" can be reduced through implementing compulsory licensing. Compulsory licensing means that a government permits "someone else to produce the patented product or process without the consent of the patent owner" (WTO, 2006c). According to TRIPS, normally, if a person or a firm wants to apply for a licence, the person or the firm has to

try to “negotiate a voluntary licence with the patent holder on reasonable commercial terms” (WTO, 2006c). If the negotiation of a voluntary licence fails, a government can issue a compulsory licence. If a compulsory license is issued by the government, the owner of a patent can still receive adequate payment (WTO, 2006c). In addition, if a government faces emergencies, such as “national emergencies, other circumstances of extreme urgency, public non-commercial use, or anti-competitive practices” (WTO, 2006c), the government can issue a compulsory license without trying to get a voluntary license first in order to save time.

7) Takalo and Kanniainen (1998) also indicated that strong IPRs protection, which increased the ability of inventors to wait and look at how feasible the innovation was, prolonged the period of waiting for commercial use of and then inhibits changes in technology. They found that stronger patent protection improved the capacity of inventors to wait for a commercial use for their inventions, which induced “delaying market introduction of new innovations”, because stronger protection could reduce losses from the entry of potential competitors (Takalo and Kanniainen, 1998:1105-1106). This implies that they believed that stronger patent protection could provide innovators with power of letting their patented technology wait for better conditions for commercialization. This kind of power can lead to the possibility that some innovators will delay commercial use of their innovations, which prolongs the time to introducing these new innovations into market. According to the analysis of Takalo and Kanniainen (1998), this is because with stronger IPRs protection, inventors do not worry about the entry of potential competitors as IPRs protection prevents others from using patented technology in protected period, and inventors do not need to worry about the loss created through the use of their innovations by potential rivals. Hence, innovators can wait and select better market conditions to put their innovative technology into commercial production. This action delays the introduction of new innovative technology to market and then holds back technological change. This negative impact of IPRs can also be decreased through issuing compulsory licences.

8) Mengistie (2003) also pointed out a negative effect of IPRs protection, especially patent, on domestic innovation. According to Mengistie, the expectation that patents could encourage local technological development and domestic innovations, could not be realised in developing countries. There is a problem on patent policy, the unused patent, in both developed countries and developing countries. It is similar to the "sleeping patent" put forward by Gilbert and Newbery (1982). As Mengistie (2003) mentioned, the problem of unused patents was more serious in developing countries, because of the commercial strategies of foreign patentees. Foreign patent owners just want to protect their market share and obstruct their domestic as well as international competitors in using their patents. Therefore, unused patents restrict domestic technological development. In addition, there are still some unreasonable articles in licensing contracts between domestic producers and foreign patent owners in developing countries, such as prohibiting local commercial use of relevant patent technology after contracts expire. These unreasonable articles also restrict the development of domestic technological capability, which then inhibits domestic innovations (Mengistie, 2003:9-10).

9) Glass and Saggi (2002) also believed that stronger IPRs protection in developing countries would decrease innovations. The reason is that stronger IPRs protection gives more security of market share for the owner of an innovation. And at the same time, more strict IPRs protection makes imitation more difficult. Under this condition, developing countries will spend more labour and resource to get a successful imitation. Thus, less resource and labour will be left for production in developing countries, while more labour and resource will be used for production in developed countries, leading to a reduction in the labour and resource used for innovation and research. Therefore, stronger IPRs protection will lead to less innovation in developing countries (Glass and Saggi 2002:408).

Besides the above literature which argued that IPRs protection had either direct positive or negative impacts on domestic technology development, there are some researchers

who believed that the relationship between IPRs protection and domestic innovation development was not straightforward but dependant on other factors.

1) Levin et al (1987) surveyed 650 American high-level R&D executives of more than 100 manufacturing industrial sectors about their opinions on industries' technological and economic environment. In the survey questionnaires, these executives were asked to rank different methods, including patent and other alternative methods of appropriation, for protecting their products and production process. Through this survey, Levin and his colleagues obtained the result that in the pharmaceutical and chemical industries, R&D executives paid more attention to patent protection. This means that patents have significant effects on encouraging innovative activities in these two industries. As for other industries, patents had not been given so much emphasis. The reason for patents being particularly useful in chemical and pharmaceutical industries was that there were "comparatively clear standards" that could be used to evaluate the validity of a chemical or a pharmaceutical patent and to avoid infringement (Levin et al, 1987:798). This means that for innovations in pharmaceuticals and chemicals, relatively explicit criteria can be used to identify whether a patent can be granted, and these criteria can also be used to prevent others from imitating patented innovations. Other industries do not have similar explicit criteria.

2) Mansfield (1986) obtained similar results to Levin's in his empirical research. He used data from 27 firms gained from "a random sample of 100 U.S. manufacturing firms" "from 12 industries" to explore the change in innovations' development and commercialization in the absence of patent and the extent that firms utilize patents, and investigated the differences that existed between firms and industries in their use patents (Mansfield, 1986:173-174). He concluded an estimated rate of innovations owned by each firm between 1981-1983 that would not have been developed and commercially produced if there was no patent for these innovations from leading R&D executives of these firms (Mansfield, 1986:174). He found that patents were quite significant for the development or commercial introduction of 30% or more of innovations in

pharmaceutical and chemical industries; important for about 10-20% innovations in the petroleum, machinery and fabricated metal products industries; and had only limited effect in the electrical equipment, office equipment, motor vehicles, instruments, primary metals, rubber and textiles industries (Mansfield, 1986:174). For office equipment, motor vehicles, rubber and textiles industries, R&D executives of these firms all agreed that patents were not significant for innovation development and commercial production (Mansfield, 1986:174). Mansfield's research also showed that without patents, 60% of the innovations of the pharmaceuticals industry and 38% of the innovations of the chemicals industry could not been developed. Moreover, R&D executives in the pharmaceutical companies indicated that about 65% of their innovations would not have been commercially used if they were not patented (Mansfield, 1986:175). In other industries, such as "electrical equipment, office equipment, motor vehicles, rubber and textiles", patents were not significant for the innovation development or introduction of new products (Mansfield, 1986: 174). But according to this empirical study, although patents were not as important for most engineering industries, there were still many firms that made use of patents. For example, in the motor vehicles industry, where patents were not paid significant attention, around 60% of patentable innovations seemed to get patent protection. Mansfield summarised the reasons for the high rate of making use of patents in industries in which patents were less important. "The prospective benefits of patent protection" including royalties, the delay of prospective imitators' entrance and that patents could also be used as "bargaining chips", were estimated by the executives in these industries as higher than the costs of obtaining patent protection. Whether patents are important for encouraging and commercially using innovations or not, companies still use patents to earn profits, which suggests that in these industries, although patents have no relation with encouraging or disseminating more innovations they are still used as tools for accumulating profits for individual firms.

3) Mansfield, Schwartz and Wagner (1981:907) also obtained data about 48 production innovations from firms in the chemical, drug, electronics and machinery industries

selected more or less at random from major firms in these four industries in the northeast of USA. They asked firms in their samples about whether they would still want to introduce their patented inventions into the market if they had no patent protection on their innovations. They got the answer that about one-half of inventions would have not been introduced into the market without a patent, and most of these inventions appeared in the drug industry (Mansfield, Schwartz and Wagner, 1981:915). Except for innovations in drug industry, only less than one-fourth of patented inventions would have been impacted in the chemical, electronic and machinery industries of their samples when a patent was not available (Mansfield, Schwartz and Wagner, 1981:915). This further proves that patents have a great impact on the commercial introduction of innovations in the drug sector and patents only have a little influence on the commercial introduction of innovations in the chemical, electronics and machinery sectors.

4) Furthermore, Taylor and Silberston (1973) also investigated the economic impact of the patent system using data from 27 firms of the United Kingdom. They illustrated the similar opinion with the above opinions. They found that R&D in the pharmaceutical and chemical industries was dependent on patent protection, while R&D in mechanical engineering and electronics industries was not quite so depended on patent protection.

5) In another research, Bessen and Maskin (2000:1) applied a model to show that if the innovation was “sequential and complementary”, patent right might decrease “overall innovation”. They gave the definition of sequential and complementary separately. They considered “sequential” means that “each successive invention was built on the preceding one”, which also meant that inventions are accumulative (Bessen and Maskin, 2000:2). And “complementary” means that “each potential innovator takes a somewhat different research line and thereby enhances the overall probability that a particular goal in reached within a given time”, which also implies that innovations are correlative with other (Bessen and Maskin, 2000:2-3). They also gave natural examples to illustrate their view, which were the developmental processes of the “software, computers and semiconductors” industries (Bessen and Maskin, 2000:2). These industries had very

rapid development in innovations with great and prompt imitation of productions. However, when the US reinforced the protection for software products, stronger IPRs protection induced "a period of stagnant, if not declining", inventive activities in "industries and firms that patented most" (Bessen and Maskin, 2000:2). Therefore, they believed that if the innovations were "sequential and complementary", imitation would be helpful for encouraging inventions and stronger IPRs protection would restrict innovations (Bessen and Maskin, 2000:2). The reasons for this were that potential rivals would be helpful for creating valuable progress based on original innovations if the innovations were sequential and complementary, and IPRs protection would reduce the pace of this kind of improvement and innovation.

6) The research by Harison (2008:84-86) paid more attention to the relation between patent and software technologies based on environment of the rapid development in personal computer and the wide use of the Internet. He considered that strict legal IPRs protection on software technologies could not provide sufficient encouragement on disclosure and diffusion of software technologies, but only set up monopoly power for software innovators. Thus, strict IPRs protection in software technologies restricted the learning and using of previous software technologies to develop new technologies in this area. He supported the open source movement as an alternative protection system for software technologies, which meant disclosing the source code and removing the ownership right. He suggested that the alternative method of open source could help to encourage the development of software technologies.

7) Cowan and Harison (2001:3) examined and evaluated whether IPRs protection policy was suitable for "the needs of knowledge-based economics in the broad context that technological changes, driven by globalization and widely-spanned information networks". This research paid more attention on the suitability of IPRs protection systems in comparatively new technologies, such as software technologies, "biotechnology, Internet and databases" (Cowan and Harison, 2001:3). They believed that developed countries promoted the establishment of global IPRs protection system.

Moreover, the appearance and development of knowledge-based technologies and rapid commercialization of information products, which were the signals of the emergence of new economy, put forward new challenges for global IPRs protection system, because the most important characteristics of the new economy was that goods could be "produced at zero marginal costs" and distributed among many users without additional costs (Cowan and Harison 2001:51). They considered that under the new economy and competitive knowledge-based products, IPRs protection could not have the positive impact on creating incentives for innovation and restricting "monopolies over infant technologies" (Cowan and Harison 2001:51).

8) Story (2004) did a research about the impact of IPRs protection on the development of new software technologies. This research compared the proprietary software, which meant that the software was owned as a kind of private property by an individual unit or person through different kinds of IPRs protection, and free software, which was also abbreviated as FLOSS from free/libre/open source software and means non-proprietary software (Story, 2004:6-7). Story (2004) found that different kinds of IPRs protection had not improved software diffusion in developing countries, but created barriers for the diffusion of software technology in the southern countries. Free software was widely used in developing countries, which also encouraged the development and improvement of software technologies in the South. This means that IPRs protection policy encumbers the development and diffusion of software technologies, however, free software strategies can create incentives for software diffusion and improvement in developing countries.

9) Lall and Albaladejo (2002) investigated the impact of stronger IPRs protection in different developing countries. They found that the impact of IPRs protection varied according to the main factors. One was "the technological nature of the activity", which meant that IPRs protection had different impacts on stimulating technological development in different innovative activities (Lall and Albaladejo, 2002:5). Patents are very significant for encouraging technology development through providing monetary

incentives to support the great and risky expenditures in R&D and commercial production of technologies in the industries where it is comparatively easy for a competitive firm to imitate new products, such as chemicals and pharmaceuticals (Lall and Albaladejo, 2002:5). However, patents are not vital for encouraging technology development in the industries, where imitation is quite "difficult and expensive", such as complex engineering and electronics (Lall and Albaladejo, 2002:5). Countries having "little productive investment in IPRs sensitive activities" need weaker IPRs protection than those countries with these activities (Lall and Albaladejo, 2002:6). Another factor was "the nature of the economy", which meant the impact of IPRs protection also varied according to different levels of the development in each country (Lall and Albaladejo, 2002:6). Countries in their early development stages should have weak IPRs protection, because weak IPRs could help domestic firms to set up technological capabilities through "imitation and reverse engineering" Countries having "little productive investment in IPRs sensitive activities" need weaker IPRs protection than those countries with these activities, which is also proved through the development experience of the Ease Asian "Tigers" (Lall and Albaladejo, 2002:6).

10) Maskus (1997) considered that the influence of IPRs protection depended on all kinds of "market characteristics" of each innovative production, which included "prospective demand, potential spillovers, the cost of R&D, impacts on market structure and competitive aspects of the economy" (Maskus, 1997:4). Different innovations had different characteristics in the market, hence the influence of IPRs protection on innovations should be considered accordingly. In addition, the implications of IPRs protection also had an indirect relationship with other policies, such as "trade and investment policies, industrial policies, including research and production subsidies, public-health and environmental regulations, and commercial controls" (Maskus, 1997:8). For an example, many countries apply price controls on pharmaceutical productions. While this policy limits the value of a pharmaceutical patent, it also decreases the attraction of the supply of pharmaceutical patents and production in the market. It is very important to keep these policies in mind when analysing the influence

of IPRs protection. These arguments show that Maskus believed that the different market traits of different kinds of innovations and innovative productions played important roles in the relation between IPRs protection and technology development. Moreover, according to Maskus, other relevant policies also had an impact on the relation between IPRs protection and domestic technology development.

11) Falvey and Foster (2006) also obtained similar results to those of Markus'. They thought that the influence of IPRs protection on domestic innovations depended on other factors. They believed that strong IPRs protection could create incentives for encouraging more innovations in countries which were comparatively well developed or with a relatively well-educated labour force (Falvey and Foster, 2006:x, 20). This indicates that, stronger IPRs can bring more benefit for creating incentives for inventive activities in countries which have high levels of development, comparative highly educated workers and an important domestic capacity for inventing. Countries having an important domestic capacity for inventing implies that these countries own abilities in resources and "human capital" (Falvey and Foster, 2006:21), which can do innovative activities and gain successful innovative technology. Furthermore, Falvey and Foster (2005) suggested that strong IPRs protection could bring more domestic innovation in comparatively "closed economies" but it could induce "less domestic innovation and more international technology diffusion in more open economies" (Falvey and Foster, 2005:7). This means that these two researchers considered that for countries, which were widely open to other countries and the international market, stronger IPRs protection could promote more technology transfer from foreign countries than domestic innovations, and for countries which were not relatively open to the international market, stronger IPRs protection could create incentives for more domestic technology than technology transfers from foreign countries.

In general, from the above explanations and analyses of different views on the relationship between IPRs protection and domestic technology development, it is obvious that some people held the view that IPRs protection had either positive or

negative impact on domestic technology development, and some people thought that the impact of IPRs protection on domestic technology development depended on other factors, such as different industries, market characteristics and other economic policies. It should say that the latter opinion is relative more reasonable because it is wise to analyse the impact of IPRs on domestic innovations according to different characteristics of innovative productions, market structures and other relevant policies, which all have implications on the relations between IPRs protection and the development of domestic innovations. The point also provides instructive information for the design of fieldwork in this research. However, there is another point that needs to be mentioned, which is that the diffusion of technology should pay more attention to the commercial use of innovations, rather than making sleeping innovations that is only helpful for creating monopoly market power without making technological development.

3.3. IPRs protection and technology transfer from foreign countries

Falvey and Foster (2006:23) summarised that technology transfer from foreign countries implied processes through which a country's companies could obtain "access to" and made use of technology produced in a foreign country. In general, technology transfer can take place through voluntary transactions between willing partners, it may also occur by "non-market transactions or spillovers" (Falvey and Foster, 2006:23). This means that technology transfer usually occurs between two parties, who want to make transactions. Sometimes technology transfer may not take place through common market transactions, such as contracts and deals but through other methods, such as imitation, flow of skilled labours and scientists as well as professionals, and spillovers. Channels, which transfer technology from one country to another, can be divided into two groups: formal channels and informal channels, depending on whether there is "formal compensation" for owners of IPRs (Falvey and Foster, 2006:24). Formal channels imply that through these manners bargainers of technology can get formal

compensation from the deal of technology transfer and purchasers need to pay to obtain the technology. Informal channels mean that through these methods bargainers cannot get formal compensation from purchasers of technology and purchasers usually do not need to pay for getting technologies transferred from bargainers. Through informal channels, even at the occasion that purchasers need to pay for obtaining technology, bargainers usually cannot gain anything because the payments received are most likely to be spent on things like imitation. Formal channels include international trade, foreign direct investment (FDI), licensing, "joint ventures", foreign patenting, which means applying patent rights in a foreign country, and "the movement of skilled workers across borders" (Falvey and Foster, 2006:24). International trade includes international "trade in goods and services" as well as international "trade in capital and intermediate goods", and the latter may be a comparatively significant way to transfer technology (Falvey and Foster, 2006:24). For FDI, inward FDI is likely to be a more important method to get technology from foreign countries; moreover, FDI channels are important for the operation of the Multinational Companies (MNCs). Informal channels involve imitation, "the movement of personnel from one firm to another taking with them specific knowledge of their original firm's technologies", patent application data, and temporary migration of people, especially scientists and university students (Falvey and Foster, 2006:24). Amongst these channels, patent application data needs to be further explained. According to TRIPS, when one applies for a patent for a kind of technology, sufficient, clear and complete information about the innovation must be disclosed in the application. Furthermore, the information revealed in application should be enough for a skilled person "in the art" to carry out and realize the innovation (WTO, 1995:332). Much of the technological information that is involved in patent application data, and most countries publish the patent application information on their patent bureau websites and therefore everyone can obtain the information. Although no one, except the patent holder, can use the whole and core technology information in the patent application, people can still get clues and research methods for carrying out relevant R&D. Therefore, patent application data can be one of the informal channels for transfer technology from foreign countries.

This section focuses on the relation between IPRs protection and technology transfer. There are some points that need to be explained in advance. Firstly, as for the relation between IPRs protection and technology transfer, there are different views from different angles. This section introduces some overall standpoints first and then focuses on some particular channels. Secondly, not all channels of technology transfer have been widely researched and discussed with respect to the relationship between IPRs protection and technology transfer from foreign countries. This section only focuses on some main channels: international trade, FDI, licensing and imitation, which have been widely discussed. Finally, this research explores the impact of IPRs protection reform on technology diffusion in China, which is a developing country. Therefore it would be helpful and relevant to place emphasis on arguments about the relationship between IPRs protection and technology transfer in developing countries.

3.3.1. The relation between IPRs and overall technology transfer

Many researchers had investigated the correlation between IPRs protection and the overall technology transfer from foreign countries. This section explores some important views.

1) Maskus (1998:134) reckoned that IPRs protection had two different and opposite influences on technology transfer. On one hand, IPRs protection facilitated and promoted technology transfer, since domestic companies can utilize information in IPRs applications to carry out follow-up innovations without infringing the original right on patented technology. On the other hand, IPRs protection could also reduce the speed of technology transfer and diffusion, as it gave owners of innovations the capability to prohibit local firms from using significant technology by adding restrictive articles in licensing agreements (Maskus, 1998:134). Bascavusoglu and Zuniga (2006) summarised these two opposite impacts by IPRs protection on technology transfer from the aspect of innovations' owners. IPRs protection could arouse "market expansion effect", which meant that firms of IPRs holders would have an increasing market in

which to sell their products and services because of the rise of demand when pirated productions had to be replaced by original ones under IPRs protection (Bascavusoglu and Zuniga, 2006:4). At the same time, IPRs protection could also bring "market-power effect", which indicated that firms of IPRs holders would decrease their sales of productions and service in foreign markets, because without menace from imitation, they had more market power under strong IPRs protection (Bascavusoglu and Zuniga, 2006:4). The first effect could help to facilitate transfer of technology to local firms, as there would be more innovative productions in the local market, which might bring great spillovers to local firms. The second effect would have a negative influence on technology transfer, because it just reinforced the monopoly market power of foreign firms with innovations and restricted the flow of technology and information.

2) Nicholson (2002:20) showed that IPRs protection had impacted on the manner of technology transfer from developed countries to developing countries, according to different production characteristics of firms. Firms holding products, which were complicated or involve sophisticated technology, would have a tendency to transfer their production through FDI, while firms, which had low risk of imitation or whose productions involved less technological information, would incline to give licensing to "on-affiliated" developing countries' firms (Nicholson, 2002:20). IPRs protection could affect both the level and composition of the transfer of technology from developed countries to developing countries (Nicholson, 2002). Stronger IPRs protection would result in enhanced transfer of technology; however it could alter the "composition from FDI to licensing" (Nicholson, 2002:1).

3) Shapiro and Hassett (2005:5-7) noticed the important role of knowledge, ideas and technologies in improving economic development all over the world. However, they believed that technology development was mainly depending on the monetary incentives provided for technological innovations. As they summarised, most advanced technologies were developed in advanced countries, such as the USA. These advanced technologies not only brought great benefit to the countries where they originated but

also created economic development in developing countries through technology transfer (Shapiro and Hassett, 2005:3). However, in their view, technology transfer from developed countries to developing countries greatly depended on whether the innovations could receive respect and protection through IPRs system in developing countries (Shapiro and Hassett, 2005:3). They indicated that stronger IPRs protection in developing countries expanded technology transfer from developed countries. Countries with weak IPRs protection could only have very little technology transfer from developed countries, especially for sophisticated technologies. Moreover, they considered that the reinforcement of IPRs protection in developing countries could also help to diffuse technologies in domestic firms (Shapiro and Hassett, 2005:4).

4) Bascavusoglu and Zuniga (2006) concluded from their research on French technology flows to other countries, which the influence of IPRs protection, especially patent rights, would reckon on the technological conditions in different countries. Furthermore, the influence also changed according to the intensity of technology and different sensitivity in different industries.

5) Falvey and Foster (2005:7) summarised from empirical evidence that the impact of IPRs protection on technology transfer relied on other factors. Stronger IPRs protection encouraged technology transfer in countries that had good "capacity for innovation or imitation", took open trade policies, and had large market size (Falvey and Foster, 2005:7). Without these conditions, technology transfer and diffusion would tend to be restricted in a country. This implies that there is the possibility of stronger IPRs protection to encourage technology transfer from foreign countries through imports, FDI, licensing and foreign patenting, but it also depends on other factors. Empirical evidence shows that when a country has resources and ability to do innovation or imitation, takes an open policy on trade, and has a great market capacity, this possibility can be realized. Without these factors, the impact of stronger IPRs protection on technology transfer from foreign countries will be very limited.

6) On the contrary, Mengistie (2003:11) summarised that patents were not helpful for

establishing joint ventures or attracting FDI in developing countries. A research done in Ghana and Nigeria found that there was only a few technologies transferred effectively to middle and low-income developing countries through FDI or joint ventures (Mengistie, 2003:11). This was because in these middle and low-income developing countries there was a lack of competent licensees to utilize and produce patented innovations independently, and that there were many difficulties for owners of patents to get hold of capable individuals to use patented innovations (Mengistie, 2003:11). One may argue that this is not a problem of IPRs protection. However, this finding shows that for the same reason, IPRs protection cannot have a positive impact on encouraging technology transfer from developed countries to middle and low-income developing countries. Some technology has been applied in developing countries not because of patent protection but because these technologies are the main part of the whole investment project (Mengistie, 2003:11). Mengistie also believed that under IPRs protection, especially patents, foreign technology holders could use unreasonable articles in licensing contracts to restrict technology transfer to developing countries, such as prohibiting licensees from doing technological development based on licensed technology, regulations that licensees had obligation to transfer their improvement based on licensed technology to licensers and restricting the use of technology by firms of developing countries, even after patents had expired. Moreover, under patent, increase in the price of foreign technology and foreign innovative productions also had a negative impact on technology transfer to developing countries (Mengistie, 2003:11).

3.3.2. The relation between IPRs and technology transfer through international trade

International trade is one of the most important channels to realize technology transfer. Some people focused their arguments related to IPRs protection and technology transfer on international trade.

1) Smith (1999:158) explored the influence of IPRs protection on the exports from 50

states of the USA and "the district of Colombia to 96 countries". Smith divided samples of these 96 importing countries into four categories according to the capability of imitation of these importing countries (Smith, 1999:155-156). Smith concluded from this research that for countries "where the threat of imitation is weak", stronger IPRs protection had a negative impact on exports of productions from the USA to these importing countries (Smith, 1999:170). Whereas for countries that "have a strong threat of imitation", IPRs protection had a positive impact on the trade flow from the USA to these importing countries (Smith, 1999:170). This means that IPRs protection in importing countries has a great relation with exports of firms in USA, and the relation between IPRs protection and trade flow from USA depends on the threat of imitation in these importing countries.

2) Maskus (2000:111) believed that it was empirically difficult to make clear the impacts of IPRs protection on international trade. There were three problems in identifying the relation between IPRs and international trade. Firstly, IPRs' impact was "partly embedded in the prices at which goods are traded" (Maskus, 2000:111). It was quite difficult to separate IPRs' impact "from other components of pricing behaviour" (Maskus, 2000:111). Secondly, exports, FDI and licensing were alternative options to sell new technologies and new products. International trade maybe just one of the choices among these options for a firm holding a new technological product. The impact of stronger IPRs protection not only affected international trade but also affected the choice among different export options. Finally, IPRs protection also "creates market power in the distribution of new goods and technologies" (Maskus, 2000:111). This implies that market structure also has relation with the impact of IPRs on international trade. Although international trade is one of the channels for transferring technology from foreign countries, it is very difficult to identify the impact of IPRs on technology transfer through international trade, because the impact of IPRs on international trade is not clearly identified. However, Falvey and Foster (2006:27) concluded that there were two direct effects of IPRs on international trade, which seemed to be especially significant. On one side, with strong IPRs protection, firms holding new goods and

technologies “should be encouraged to export their patented goods into foreign markets” (Falvey and Foster, 2006:27). This arises because that IPRs protection reduced the risk of imitation, which decreased the “profitability of the firms’ activity in that country” (Falvey and Foster, 2006:27). From this point, stronger IPRs could be expected to encourage imports to a country. On the other side, stronger IPRs protection also increased the market power of firms holding new technologies, because the protection “reduces the ability of domestic firms to imitate” (Falvey and Foster, 2005:24). With more market power, the exporters might be encouraged in a monopolistic way through reducing sales (Falvey and Foster, 2006:27).

3) Fink and Maskus (2005:7) generalised the relation between IPRs protection and technology transfer through international trade. Firstly, multinational trading firms seemed not to “base their export decision on IPRs in the poorest countries, where the local threat of reverse engineering were weakest” (Fink and Maskus, 2005:7). This means that multinational trading firms do not consider IPRs protection when exporting to the poorest countries, because there is little risk of imitation in these countries. Secondly, in middle-income and large developing countries, patents were an important factor that affected the export decision of multinational trading firms, because imitations were more likely to occur in these countries. Thus, if these countries implemented stronger IPRs protection, which reduced the risk of imitation, foreign trading firms were “more likely to expand their volumes of trade accordingly” (Fink and Maskus, 2005:7). Thirdly, “the products of many high-technology industries are inherently difficult to imitate, so those trade flows are less responsive to IPRs than those in medium-technology or mature-technology sectors” (Fink and Maskus, 2005:7). This implies that products of some industries containing high-technology, which is difficult to copy, are less sensitive to IPRs protection than products of some industries containing technology that is easy to copy. This also means that different sectors have different sensitivities to IPRs protection. Finally, high-technology firms might select FDI and licensing to sell new technologies and new products internationally. Thus, the change of IPRs protection seemed to have very limited impact on international trade in these firms

(Fink and Maskus, 2005:7).

4) Fink and Primo-Braga (1999:2-9) found that although strong IPRs protection had a positive influence on "trade flows for both total non-fuel imports and exports", IPRs protection had a negative influence on trade flow in high-technology productions. They gave some possible reasons for this: for high-technology products "market power effects might offset positive market expansion effects" aroused by strong IPRs protection; firms with high-technology products preferred to use FDI to replace international trade; trade flow of high-technology productions might not be sensitive to IPRs protection; moreover, there were other factors that could have impacts on trade of high-technology productions (Fink and Primo-Braga 1999:10).

3.3.3. The relation between IPRs protection and technology transfer through FDI

The channel of FDI in technology transfer is comparatively complex. It has not been agreed whether FDI can bring technology transfer or spillovers, however, FDI is at least a possible channel that can bring technology transfer from foreign countries. If stronger IPRs protection can bring more FDI to a country, then more technology may be carried from foreign countries through this channel. If stronger IPRs protection cannot bring more FDI to a country, it is impossible to get technology transfer through FDI. Therefore, this section introduces different views on the relation between IPRs protection and FDI, especially related to technology transfer.

1) Maskus (1998) indicated that IPRs protection was a significant aspect but not the only factor to have influence on FDI. Just increasing IPRs protection alone could not help to encourage FDI sufficiently (Maskus, 1998; Fink and Maskus, 2005:54). The "general regulatory system", which included IPRs protection, "taxes, investment regulations, production incentives, trade policies and competition rules", had important impacts on FDI (Maskus, 1998:129; Fink and Maskus, 2005:54). Moreover, IPRs

protection had a different influence on FDI in different industries. The decision of FDI in lower-technology industries, such as textile and electronic assembly, was not sensitive to the change of IPRs protection but was depended much on "input costs and market opportunities" (Maskus, 1998:131-132; Maskus, 1997:17). Foreign firms with productions and technology, which was quite difficult to be copied, also paid less attention on IPRs protection when making decision on FDI. Firms that had easily imitated goods, such as chemical goods, pharmaceutical goods, and software, would pay more attention to IPRs protection when deciding to implement FDI locally (Maskus, 1998:131-132; Maskus, 1997:17).

2) Falvey and Foster (2006:33) summarised that for countries that had some technology absorptive abilities, inward FDI was a source for technology diffusion. IPRs protection could influence technology diffusion through the channel of inward FDI, because the change of IPRs protection could affect the flow of FDI. However, the relation between IPRs protection and FDI was not straightforward. Stronger IPRs protection encouraged FDI in some industries, such as chemical and pharmaceutical industries. The relation between IPRs and FDI also depended on the level of production stages. Stronger IPRs protection could encourage more FDI in "component manufactures final production and R&D facilities" than in other levels of production stages (Falvey and Foster, 2006:33).

3) Smarzynska (2004:40) explored the impact of IPRs protection on the composition of the flow of FDI in 24 economies in Eastern Europe and the former Soviet Union. She found that weak IPRs protection would reduce FDI flow in four high-technology industries including "drugs, cosmetics and health care products; chemicals; machinery and equipment; and electrical equipment", where IPRs protection was quite significant (Smarzynska, 2004:40). Meanwhile, weak IPRs protection also shifted the emphasis of FDI in target countries from "manufacturing to distribution" (Smarzynska, 2004:40). At the same time, the impact of weak IPRs protection on the transfer of FDI emphasis was important to all kinds of investors, not just FDI in high-technological industrials, which were highly sensitive to IPRs protection (Smarzynska, 2004:40). The transfer of FDI

emphasis from manufacturing to distribution means that there is less possibility to transfer technology through FDI, because technology contained in distribution is far less than that contained in manufacturing.

4) Saggi (2000) obtained the results from surveys of literatures on trade and FDI that IPRs protection policy in a country had influence on attracting technology from foreign countries in different industries. Firms in industries which were sensitive to IPRs protection, such as pharmaceutical industry, would not do direct investment or do investment in manufacturing and R&D in countries that had very weak IPRs protection (Saggi, 2000:39). This means that the relation between IPRs protection and FDI depends on different industries. Moreover, the change on IPRs protection can also have impacts on technology transfer through different kinds of channels, such as licensing, joint ventures or FDI.

3.3.4. The relation between IPRs protection and technology transfer through licensing

Licensing is another important formal channel for technology transfer. Through licensing, intellectual property owners permit others to use IPRs, especially patented technology, under negotiated conditions. Technology transfer mostly involves technology licensing, through which the owner of a kind of technology protected by IPRs permits others to utilize, modify, and resell this kind of property based on negotiated compensation. There are also some particular arguments on the relationship between IPRs protection and technology transfer through licensing, which are explored in this section.

1) Maskus (1997:19-20) considered that licensing was very sensitive to the strength of IPRs protection, although he concluded that the correlation of IPRs protection and licensing also depended on other factors, such as “local supply of technical and managerial personnel, market factors and collateral regulation”. Maskus also gave

reasons for it: strong IPRs protection would lower the costs of licensing through decreasing the expense in prohibiting defection in licensing contracts by licensors; stronger IPRs protection also gave more secure guarantee on technological information in licensing contracts; and rigorous IPRs protection could also provide capability for licensors to control licensing terms (Maskus, 1997:19-20).

2) Mansfield (1995:9) concluded from research that licensing had great relation with IPRs protection in the USA, Germany and Japan. Firms in these countries would not undertake licensing under conditions of weak IPRs protection. In addition, the relationship between IPRs protection and technology licensing had more significant embodiment in chemical and pharmaceutical industries.

3) However, Falvey and Foster (2005:31) pointed out that although licensing was sensitive to IPRs protection, stronger IPRs protection, which gave greater monopoly market power to licensors, lowered innovation and then decreased further licensing.

3.3.5. The relation between IPRs protection and technology transfer through imitation

Imitation is a very significant informal channel that helps to transfer technology transferred from foreign countries. Imitation is especially important for most developing countries, which do not have the capability to do R&D themselves and cannot afford high royalty payments for getting patented technology. This section focuses on arguments about the relation between IPRs protection and technology transfer through imitation.

1) Lai (1997; Kanwar and Everson, 2003:239) pointed out that if imitation was the channel of technology transfer in developing countries, stronger IPRs protection would reduce technology transfer from developed countries.

2) As Fink and Maskus (2005:61) summarised, Glass and Saggi also believed that if

developing countries could only get innovations through imitation from developed countries, stronger IPRs protection obtained through adopting minimum standards of global IPRs protection systems would bring more difficulties in doing imitation because of the force from foreign patent. If there was a reduction in the rate of imitation, there would be an expectation by innovative companies in developed countries that their losses in "technological advantages" would slow down (Fink and Maskus, 2005:61). As a result, these innovative companies in developed countries would try to earn profit as much as possible from each of their innovations, which would make their need for doing more innovative activities decline.

3) In the research of "Intellectual property rights, technology and economic development: experiences of Asian countries", Kumar (2002) introduced IPRs protection system and its impact on technology and economic development in Asia, such as Japan, Taiwan, South Korea and India. This research showed that Japan, Taiwan and South Korea in their early stages, applied weak IPRs protection policy to facilitate domestic firms in absorbing foreign technologies through reverse engineering (Kumar, 2002:4-6). Meanwhile, during the period of weak IPRs protection policy, Japan, Taiwan, South Korea also encouraged the development of their domestic technology based on the technology absorbed through reverse imitation from foreign advanced countries. Therefore, technology obtained fast development in Japan, Taiwan, and South Korea during their weak IPRs protection period. After Japanese firms gained enough technological ability and adequate technological development, the Japanese government started to adopt strict IPRs protection policy to prevent technology imitation (Kumar, 2002:4-6). Taiwan and South Korea were pushed by the USA to adopt stronger IPRs protection policy (Kumar, 2002:4-6). However, at the time of applying stronger IPRs protection policy, Taiwan and South Korea had obtained enough time to develop their technology under their weak IPRs protection through imitating advanced technology from foreign countries. These three examples illustrated that weak IPRs protection policy, especially permitting technology imitation from advanced countries and the policy of encouraging the development of domestic technology strongly promoted

technological development and diffusion in Japan, Taiwan and South Korea. India had to accept a strict IPRs protection policy in 1911 (Kumar, 2002:6). However, under the pressure form Indian domestic industry, the Indian government adopted weak IPRs protection policy. This weak IPRs protection policy facilitated Indian firms in absorbing technology through reverse imitation from advanced countries and in developing their technological abilities, especially in the chemical and pharmaceutical sectors (Kumar 2002:6). This example also shows that weak IPRs protection promotes reverse imitation and strongly encourages absorbing technology from foreign countries.

4) Kim (2003:5-6) also found from a research done about the development experience of South Korea that "in the early stage of industrialisation", reverse engineering and imitating advanced technological products from foreign countries could help to facilitate transferring and absorbing technology from foreign countries and then enhanced the technological infrastructure in domestic industries. He mentioned that stronger IPRs protection policy, which strictly prevented imitation and reverse engineering, would greatly encumber technology transfer. Kim (2003:5-6) concluded that only after countries obtained enough "accumulated indigenous capability with extensive science and technology infrastructure to undertake creative imitation in the later stage", IPRs protection policy turned out to be an significant factor that influences technology transfer. Kim (2003) also indicated that weak IPRs protection together with the tolerance of imitation was not useful for South Korea. In other New Industrial Economies in Asia, such as "Thailand, Malaysia, Indonesia, Vietnam, and the Philippines", imitation and weak IPRs protection also helped to obtain mature technology transfer from foreign countries in their early development stage (Kim, 2003:2). Moreover, Kim (2003:6) considered that without the tolerance of imitation under weak IPRs protection in the early stages of development, "Japan, Korea and Taiwan" could not have obtained their current levels of technological development. This also shows that weak IPRs protection and imitation encourage technology transfer for developing countries when they are in early development stage.

3.4. Conclusion

To conclude, this chapter introduces and analyses different arguments on the relation between IPRs protection and technology diffusion from two aspects—IPRs protection and domestic technology development as well as IPRs protection and technology transfer from foreign countries.

Through analysing these different arguments, the following points can be generalised: 1) Of different opinions on the relation between IPRs protection and domestic technology development, some supported that stronger IPRs protection encouraged domestic innovations, some believed that weak IPRs protection was helpful to create incentive for innovative activities locally, and others considered that the relation between IPRs protection and domestic technology development depended on third factors, including other relevant policies and the characteristics of different industries. It is wise to analyse the correlation between IPRs protection and domestic technology development according to different conditions and traits, because IPRs protection is not the only factor that affects domestic innovation. Aggregative conditions, including IPRs protection, other relevant policies and characteristics, influence domestic technology development greatly. This proves that the relation between IPRs protection and domestic technology development varies under different conditions, including different industries and other relevant policies. This is very helpful for designing fieldwork and analysing fieldwork data for this research, because it urges the researcher to consider the characteristics of these conditions when analysing the relationship between IPRs protection and domestic technology development. Furthermore, in the relation between IPRs protection and domestic technology development, the most important point is to make commercial use of innovations and do further developments based on existing innovations, rather than letting innovations go to sleep. In addition, more monopoly market power induced by stronger IPRs protection can increase the price of innovative productions and limit distribution of inventions, which can be harmful for technology diffusion.

2) For the relationship between IPRs protection and technology transfer, there are formal and informal channels. This chapter analyses some important channels—international trade, FDI, licensing and imitation. Technology diffusion in this part is quite complex. 1. There was no consistent opinion about whether FDI was a channel for technology transfer, because some believed that FDI could bring technology and spillovers while others held the opposite opinion. 2. There was a complicated relationship between formal channels and informal channels. Stronger IPRs protection, according to some researchers, could promote most formal channels such as international trade, FDI and licensing, while it was considered to reduce imitation at the same time. 3. Among formal channels, there was still a complex issue: the increase in the strength of IPRs protection would be likely to enhance licensing to replace FDI. Generally, there was not an agreement on whether IPRs protection or stronger IPRs protection could bring more technology transfer. Some people considered that stronger IPRs protection could encourage more technology transfer, but some did not. In addition, the characteristics of different industries were also considered to have a correlation with technology transfer. Therefore, while designing fieldwork and analysis in this research, the characteristics of different industries and the characters of the country are taken into consideration. Two more additional points are worth mentioning: first is that the cost of technology transfer is quite important, because it decides whether a firm or a country could afford the technology. If the price is quite high as foreign firms have tighter control of their technology given by stronger IPRs protection, technology transfer is unlikely to take place because domestic firms cannot afford it. The second one is that technology transfer should be helpful in developing domestic innovations. It should not produce technological dependency on foreign innovations, which is harmful for long-term technology development and diffusion.

As mentioned before, these different discussions on the relation between IPRs protection and technology diffusion in the aspects of domestic technology development and technology transfer from foreign countries are very helpful for designing and analysing fieldwork for this research.

Chapter 4

The background of IPRs protection development in China

4.1. Introduction

Similar to other developing countries, China has a quite short history in the development of IPRs protection. However, China has made considerable progress in promoting the development of IPRs protection over the past decades. After reviewing IPRs theories and arguments related to IPRs and technology diffusion, it is necessary to understand the background of IPRs protection development in China for this research. The necessity of reviewing China's IPRs development embodies the following points. 1) There are two basic questions in this research: did China's entry to the WTO really lead to the fact that the country enforced stronger IPRs protection and when did it start to enforce stronger IPRs protection? IPRs development in China can provide information for these two questions. 2) The background of China's IPRs protection also helps to select research methods. IPRs reform in China mainly occurred from the 1980s to the beginning of the 21st century. This research explores the impact of IPRs protection reform on technology diffusion in China and compares technology diffusion before and after IPRs protection reform in China. Thus, necessary methods that can help to recall the impact of IPRs on technology diffusion before IPRs protection reform are used in this research. 3) The background of China's IPRs development is also helpful for analysing and understanding the research result.

This chapter introduces the history and development of IPRs protection in China at different stages. Generally, there was no significant development on IPRs before China opened its door to the world in 1978. IPRs protection obtained real development after

China implemented the "Open Door" policy in the late 1970s. There have been three development climaxes on IPRs protection after the 1980s, and there are different causes for each it.

4.2. China's IPRs development before the "Open Door" policy

In 1949, the Chinese Communist Party (CCP) established the People's Republic of China (P.R.C). Before the establishment of P.R.C, the CCP had abolished all regulations and laws, including copyright, patent and trademark law, implemented by Kuomintang party, which controlled China from 1911 to 1949 (Yang, 2003; Jin, 2004). During the first 30 years of the P.R.C., which was also "a period of extreme economic planning", the government applied "a reward system" for innovations "under the auspices of official documents" (Yang, 2003:134). Chinese government implemented strict administrative control over innovations and publications. Based on an extremely planned economy, "public ownership was advocated", and the national interest and social welfare were superior to individual interest (Bosworth and Yang, 2000:456). IPRs protection system was opposite to a planned economy in the view of "Marxism, Leninism and Maoism", because IPRs protection was based on the concept of private property and Marxism, Leninism and Maoism advocated public property (Yang, 2003:134). Therefore, in this period, no formal IPRs protection system was in place during the first thirty years of the P.R.C. when Chinese government implemented the planned economy (Hong, 2005).

After the establishment of the P.R.C, the government took the "Soviet model" in IPRs area, because it was closer to the "traditional Chinese attitudes toward intellectual property" (William, 1995:56). In the traditional Chinese view, intellectual creation and innovations should belong to the whole society, because Chinese people believe that intellectual inventions are fruits of social activities (Andrew, 2005). The Soviet model of intellectual property means a "two-track" system, that the government can give the "certificates of invention" or the "certificates of patent" to innovators to protect their

rights (William, 1995; Jin, 2004). William (1995) summarised that the preferred track was to use the certificates of inventions. With these certificates, inventors are entitled to have the rights of being recognized and getting monetary rewards created by their innovations. However, these inventors must let the state use and disseminate their innovations. In August 1950, the government approved the "Provisional Regulations on the Protection of Invention Rights and Patent Rights", which was taken from the "Soviet model" (William, 1995:57). This regulation means that at that time, the government recognized patent rights; yet the government had the right to decide "whether and how" these innovations "could thereafter be applied by other Chinese entities without prior approval or the payment of a licensing fee" (William, 1995:58). Therefore, this regulation also meant that the government wanted to transfer to an award system on IPRs protection (Andrew, 2005:80). In May 1954, the government promulgated the "Provisional implementation regulations of rewards on industrial inventions, innovation and rationalisation proposals", which changed the rights of innovations "from private ownership" to be fully controlled by the state (Yang, 2003:134). According to this regulation, innovators can get "bonuses, medals, certificates" "honorary degrees" in term of innovation ownership, which was "set between three to 15 years" (Yang, 2003:134). However, these regulations could not get implemented well because of "the Anti-Rightist Campaign of 1957-58" and "the Cultural Revolution" of 1966-77 (Andrew, 2005:81). Thus, relevant policies in that period could not encourage innovative activities, and achievement from R&D was at quite a low level (Yang, 2003:135). The government only granted "four patent rights and five innovations" during the period "between 1950 and 1963" (Bosworth and Yang, 2000:456), and only registered "7700 items of scientific and technological" fruits from 1966 to 1978 (Bosworth and Yang, 2000:456).

For trademarks, the Chinese government promulgated the first trademark statute in 1950, which was the "Provisional statute on trademark registration and its implementation statute" (Yang, 2003:134). Although this regulation provided 20 years' protection for trademarks together with indefinite renewal, there were no specific provisions on how

to enforce the protection (Yang, 2003:134). In 1963, the Chinese State Council used the "Regulations governing the control of trademarks" to replace previous trademark regulations (William, 1995:63). The aim of this new regulation was to strengthen "the control of trademark" and make "enterprises guarantee and improve the quality of their products", rather than to protect the rights (William, 1995:63).

For copyright, China implemented a reward system before the "Open Door" policy (Yang, 2003). This reward system was not a formal IPRs protection. The social and cultural background directly restricted the establishment of formal IPRs protection system in the early period of the P.R.C. As Jiang (2007:1) summarized, "family thought" shaped Chinese culture. Actually, Chinese people consider the whole of China as a kind of "private property of the imperial family", which leads to the fact that all families, except the imperial family, "shared collective property" because they had no private properties (Jiang, 2007:1). Moreover, in the traditional Chinese view, a book taken from others was not a stolen book and Chinese authors thought that coping of their works was a kind of "supreme honor" (Jiang, 2007:1). These traditional views could not be changed in short period after the establishment of the P.R.C., so there was no formal copyright system, which emphasised private property rather than public property in the early period of China. In 1950, the government held the first meeting on countrywide publishing. In this meeting, the government passed the Decision on improvement and development of publishing, which stipulated the principle for copyright (Li, 2005:73). In 1955, the government sketched out the Statute on copyright protection for publications, but because of the "Cultural Revolution" this statute was not published (Li, 2005:73). As William (1995:59) summaried, during the early period of the P.R.C, there were "no comparable provisional regulations" related to copyright. Chinese authors and scholars could only receive the "fixed 'basic payments'", which were based on the "number of copies printed", besides holding the right of preventing "unauthorized alteration of their work" (William, 1995:59). According to Jin (2004:188), although there were some regulations and governmental documents on copyrights, these regulations and documents paid more attention to the benefit of publishing houses,

rather than the rights of authors. Moreover, from the beginning of the Cultural Revolution in 1966, the already limited basic payment to authors was reduced dramatically. Authors could not even ask for the their works to bear their names, and they could only sign "collective creation" on their works.

There are some reasons for the slow development of IPRs protection in China before the "Open Door" policy. The main reasons were internal: the slow development of IPRs protection was the result of special political, economic and social conditions in China. In the first thirty years, the CCP implemented a strict socialist command economy. This economy was thorough the "planning economy" (Li, 2006), which meant that all kinds of assets belonged to the commonality or collectivity. This policy believed that individual welfare was subordinate to social and national welfare, which resulted in despising private property (Bosworth and Yang, 2000:456). Under this policy, any technological innovations should belong to the state, and technology innovators could only get very limited rewards for their creations. Trademark registration was also a kind of method to control all kinds of units and their production (Li, 2006). IPRs for individuals did not give protection or development. Secondly, the system of policy-making had no participation for individual persons, which was established in imperial society and continued for a long period of time in China's history. This system also set up a hierarchy society and created a "high-level of bureaucracy in China" (Yang, 2003:135). Thus, different levels of governments in China had powerful impact on "all aspects of economic and social activities", including the control of innovative activities and their results (Yang, 2003:135). Moreover, the P.R.C was established on the basis of a traditionally feudalistic society and foreign aggression as well as civil wars, which pushed the government to pay more attention to the construction of basic infrastructure. This left China with little energy to develop science and technology and also restricted the development speed of IPRs. Finally, China experienced the 10-year Cultural Revolution from the late 1960s. During that period, researchers, teachers, technicians and intellectuals received serious persecution. Many researches had to halt. Many books, papers and other kinds of works were destroyed. The development of science and

technology encountered a great calamity in the country. In the same period, all kinds of thought that had connection with capitalism or individualism received criticism. Relevant regulations on science and technology, especially IPRs protection, which were introduced from western countries, could not develop quickly. For the external reasons, although the P.R.C was established in 1949, it was not admitted by many foreign countries in the early stage, especially by developed countries. Thus, there was very little international trade and communication between China and developed countries, which also restricted the introduction and development of IPRs system.

4.3. China's IPRs development after the "Open Door" policy

After China implemented the "Open Door" policy in 1978, Chinese IPRs protection achieved tremendous development. It took about 20 years for the government to set up comparatively high level of IPRs protection system, which is also consistent with international IPRs protection standards (Li, 2005:74). This is also the formal establishment of contemporary IPRs protection in China. This rapid development can be analysed through three development climaxes.

4.3.1. The first development climax in the early stage of 1980s

In the late 1970s, the Chinese government gradually realised the importance of an IPRs system. Without IPRs protection foreign companies would not do invest, bringing their technologies to China. Moreover, the Chinese government recognised that IPRs protection was also an indispensable system to stimulate domestic innovation (OECD, 2003:118). Just after China opened its door in 1979, the Chinese government came to "the Agreement on Trade Relations between the USA and the P.R.C" ("1979 Agreement") in September 1979, which provided for the protection of copyrights, patents, and trademarks "to the nationals of the other party" (Yu, 2002:8). From that time, the Chinese government started to do IPRs protection reform to establish a broad IPRs protection system. According to this agreement, the Chinese government

authorized the National Publishing Institution of the P.R.C to draft the copyright law (Li, 2005:76). In the beginning of 1980, the government established the State Patent Office of the P.R.C to take charge of drafting the first patent law (Li, 2005:76). In the same year, China entered the WIPO, according to the requirement of "1979 Agreement" (Yu, 2004:4). A new trademark law was issued in August 1982. The country promulgated a new patent statute in 1984, which was the first integrate patent statute in the P.R.C, and joined "the Paris Convention for the Protection of Industrial Property" in 1985 (Yu, 2002:8; Li, 2005:76). In 1985 the government established the National Copyright Administration of P.R.C (Yu, 2002:8; Li, 2005:76). Before 1990, China had also signed "the Madrid Agreement for the International Registration of Marks" (Zhang, 2006:64-65) and "became a signatory country for the Integrated Circuits Treaty" (Yang, 2003:136). Although the Chinese government promulgated some IPRs regulations and signed some international agreements during this period, Chinese authors and innovators could only receive very limited protection for their works and creations, because it was quite difficult for China to introduce the notion of private property, which was opposite to "the socialist economic system", and the government had to put "substantial limits" on relevant rights about IPRs protection (Yu, 2002:8).

4.3.2. The second development climax in the early stage of 1990s

Although there were some developments on IPRs in China, developed countries, especially the USA, was not satisfied with them. In 1989, China was placed on "priority watch list" by the "US Trade Representative" under "section 301 of the Trade Act" (Li, 2005:77;Yu, 2002:.9). The "section 301 of the Trade Act" provided rights of investigating and imposing sanctions on relevant countries, which were considered to embark on "unfair trade practices" that threatened the USA's economic interests, to the USA President (Yu, 2002:9). In order to give response to this before the negotiation with the USA on IPRs protection, the Chinese government passed the first copyright law in 1990 and promulgated a separate regulation on computer software protection in 1991 (Li, 2005:79). Nevertheless, China was placed as "a priority foreign country" by

the USA in 1991 (Yu, 2002:9). In order to avoid a trade war between the two countries due to the retaliatory behaviour, China and the USA signed “the Memorandum of Understanding Between China and the United States on the Protection of Intellectual Property” in 1992 (Wang, 2002:3). China promised in the 1992 Memorandum that it would promote its IPRs protection, especially for the protection on “patented pharmaceuticals, chemicals and copyrighted materials (including computer software)” (Michel, Pitman and William, 1996:7). During this period, China approved “the Statute on Computer Software Protection” (Yang, 2003:136). Under the pressure of the 1992 Memorandum, the Chinese government amended the patent statute and issued “the implementation Regulations on the Patent law” (Yang, 2003:136) in 1992, which enlarged the scope for patent and prolonged the protective term from 15 years to 20 years for patents (Li, 2005:79). In 1993, the Chinese government also amended its trademark law and announced “the Implementation Regulation on the Trademark Law” (Yang, 2003:136). This modification added criminal penalties for trademark infringements (Wang, 2002:4). Furthermore, China joined “the Berne Convention for the Protection of Literary and Artistic Works” (Wang, 2002:2-3) and the World Copyright Treaty in 1993 (Yu, 2002:10). The country also became a member of “Geneva Convention for the Protection of Producers of Phonograms Against Unauthorized Duplication of Their Phonograms” and “the Patent Cooperation Treaty” (Yu, 2002:9-10; Li, 2005:79). In addition, the government also issued countering unfair competition law in 1993 (Li, 2005:79), whose main purpose was to protect “trade secrets and know-how” as well as to encourage “fair trade and competition” (Yang, 2003:136). Meanwhile, China also advanced the enforcement system for IPRs protection. The most obvious symbol of this improvement was the “establishment of the intellectual property Special Court in 1992”, which assured that all kinds of intellectual property cases could be reviewed and get “unified enforcement” (Yang, 2003:136).

4.3.3. The third development climax from mid-1990s to the beginning of the 21st century

In 1994, the USA Trade Representative used the "Special 301 Process" to put "China as a Priority Foreign Country" again (Hong, 2005:298). Under this situation, the USA pushed China to sign "the Agreement Regarding Intellectual Property rights" in 1995 (Yu, 2002:10-14). Wang (2002) summarises that this also resulted in the second memorandum of understanding between China and the USA in 1995. Based on the 1995 memorandum, China promised to take measures to provide sufficient IPRs protection for USA right holders (Wang, 2002). At the same time, the government paid more attention on IPRs protection enforcement. China established "an Action Plan for Effective Protection and Enforcement of Intellectual Property Rights ("Action Plan"), whose main purpose was to improve "the enforcement structure and the legal environment" related to IPRs protection (Wang, 2002:5). The "Action Plan" set up "a new enforcement structure", which was the "State Council Working Conference on Intellectual Property Right" (Wang, 2002:5). The main aim of this "Working Conference" was to make sure that all kinds of regulations and laws relating to IPRs protection could be implemented across the whole country to prevent "local protectionism and vulnerability of the Chinese judicial system" (Wang, 2002:5).

In 1995, the USA used the "Special 301 Process" to place China as "a Priority Foreign Country" for the third time (Yu, 2001:10). China and the USA had to come to another agreement, which "included a Report on Chinese Enforcement Actions" and "Annex on Intellectual Property Rights Enforcement and Market Access Accord" in 1996 (Zhang, 2006:74-75). The 1996 agreement paid more attention to the "administrative enforcement of copyright law and market access" for "audio-visual and published products as well as computer software" from the USA to China (Zhang, 2006:74-75). Under the 1996 agreement, China had to take measures to reinforce IPRs protection. As a result, the government promulgated the "Regulations on the Certification and Protection of Famous Trademarks" in 1996, which made regulations consistent with the

requirements of the TRIPS agreement (Yu, 2001:5-6); the "Regulations on the Protection of New Plant Varieties" in 1996 (Yu, 2004:5); a section for "intellectual property crimes" in 1997 (Yu, 2001:6). In addition, the government also upgraded the "State Patent Bureau" to the "State Intellectual Property Office" in 1998, which was "a ministry-level branch of the State Council" (Yu, 2004:5) and whose main functions were to improve "trademark, copyright, patent application and management and other intellectual property rights aspect" and to cooperate with "the State Administration of Industry and Commerce and the State Press and Publication Administration" in order to affirm the implementation of "laws and regulations" (Yu, 2001:6). And in 2000, the country joined the "International Union for the Protection of New Varieties of Plants" (Yu, 2004:5).

In the same period, China was trying to be accepted by the WTO and made more progress on IPRs protection. In 2000, the second amendment for patent law was made. The government amended copyright law in 2001, which was the first amendment for the copyright law after its implementation (Li, 2005:82). This amendment strengthened copyright protection and added computer software as one of the objects for copyright. In the same year, the government modified its trademark law and reinforced the strength of trademarks protection (Li, 2005:83). In November 2001, China was acceded by the WTO and signed the TRIPS agreement, which meant that China must obey the minimum protective standards set by TRIPS. Not long after China's entry to the WTO, the country promulgated relative regulations for copyright and trademark, and issued enforcing regulations on "integrated circuits, computer software and pharmaceuticals" as well as other steps to develop IPRs protection (Yu, 2004:6). The central government together with other relevant departments launched some "large-scale crackdowns on pirated and counterfeit productions" in many kinds of sections and productions, which obtained remarkable results (Yu, 2004:6).

Some internal factors for the rapid IPRs development after the 'Open Door' policy need to be analysed. Firstly, after the "Open Door" policy, China entered a new stage for

reconstruction and development in all perspectives. The government took a policy of market economy, which broke up the "iron rice bowl" system that provided equal reward to all kind of labourers without considering the quality of their work (William, 1995:67). The market economy policy allowed and encouraged individuals to pursue their own profits and interests through providing "meaningful material incentives" (William, 1995:67). It changed the minds of Chinese people from believing that social welfare was above individual interest in accepting that it was reasonable to seek individuals' proper interest. This had provided a foundation for IPRs establishment in ideology. Secondly, under peaceful circumstances, Chinese people and the government tried hard to embark on all kinds of production and R&D that were beneficial to enhance productivity. Science and technology in China obtained rapid development after the "Open Door" policy, which called for relatively systematical IPRs protection to safeguard scientific and technological fruits and to encourage more creative productions. This new situation created the need for IPRs protection, and the government gradually noticed the importance of IPRs. The establishment of IPRs protection satisfied China's desire to protect China's domestic technology (Yang, 2003:136). Last but not the least, China wanted to be accepted by the GATT, which was the predecessor of the WTO, to enlarge its international trade and promote Chinese economic development from the late of 1980s. The GATT, under the control of most developed countries, requested China to improve its IPRs protection as one of the terms for entry. After the establishment of the WTO, TRIPS became one of the components of the WTO agreements, which meant that every WTO member must accept TRIPS as the minimum standard for their IPRs protection. Therefore, China had to improve its IPRs protection according to the requirements of TRIPS. Under the pressure, IPRs protection in China developed very fast after the "Open Door" policy.

There are also some important external factors for the rapid development on IPRs in this period: the pressure from the USA, especially, played a significant role. After China opened its door to the world, there was a great increase in the international trade and foreign investment in the country. Products in developed countries, which had

comparative mature IPRs protection, flowed into China. Foreign countries also invested in China to engage production directly, and these countries required IPRs protection for their products. International communication augmented dramatically, which let Chinese people and their government know and learn about relevant economic and legal system, including IPRs protection, from developed countries. Pressure came from developed countries, especially the USA, and should be described separately, because it was one of the main reasons for the rapid development on IPRs protection in China. As mentioned above, the USA used the "301 section" and the "Special 301 section" to place China in the "Priority Foreign country" category many times to condemn the poor IPRs protection in China. In order to avoid a potential trade war with the USA, China had to compromise every time, which became one of the main impetuses to improve Chinese IPRs protection. Many IPRs protection reforms in China were made under the pressure of the USA. Moreover, the USA was one of the most important countries for China's entry to the WTO. In order to be acceded by the WTO, China needed the support from the USA. And therefore, China needed to satisfy the relevant requirements put forward by the USA. As IPRs protection was one of the most significant issues that the USA concerned about in China, Chinese government had to improve IPRs protection. Moreover, China wanted to obtain new advanced technology from foreign firms in developed countries (Yang, 2003:136-137). Without IPRs protection, firms in developed countries would not want to transfer their technology to China, because they worried that their technology would be imitated at very low cost by other Chinese firms, which would reduce their benefit greatly. The establishment of IPRs protection also satisfied the need of Chinese government to attract technology transfer from foreign countries.

4.4. Conclusion

To conclude, this chapter introduced the development history of Chinese IPRs protection from different stages, which includes IPRs development before and after the "Open Door" policy. Moreover, China's IPRs protection development after the "Open Door" policy is also divided into three development climaxes. This chapter also

analysed the factors of the development progress in different stages. According to this analysis, there are internal and external factors for both the slow development on IPRs protection before the “Open Door” policy and the rapid improvement on IPRs protection after the “Open Door” policy. Internal factors were more significant for slow development on IPRs protection before the “Open Door” policy, while external factors, especially the pressure from the USA, played a very crucial role in the expeditious development on IPRs protection after the “Open Door” policy. The introduction and analysis provide very useful backgrounds for doing fieldwork and analysing fieldwork data in this research.

Chapter 5

Research methodology

5. 1. Introduction

This research is about China's entrance to the WTO and the influence of IPRs protection reform on technology diffusion. This research used fieldwork to collect data and information. The review of IPRs theories, arguments related to IPRs and technology diffusion and the background of China's IPRs development provided useful information for fieldwork design in this research. This chapter explores the selection of methods for doing fieldwork and collecting data in this research. It begins with the definition and explanation of its fieldwork questions, and explains the fieldwork methods, which include semi-structured interviews, self-completion questionnaires, and data collection from official statistics and other sources. Reasons for using these methods, the limitations of them and how to overcome the limitations are analysed. Detailed fieldwork plans and difficulties for doing this fieldwork are also provided in this chapter.

5.2. Fieldwork questions

This research explores the impact of IPRs protection reform obtained in the WTO accession on technology diffusion in China. Since there was no relevant data or documents available for this research, the best way to collect them is through fieldwork, which was then carried out in China. IPRs theories and arguments related to IPRs and technology diffusion reviewed separately in chapter two and three provided information for how to achieve the research objectives through fieldwork. IPRs theories indicated that IPRs establishment might bring both positive and negative impact on technology

development. These theories also showed that the current IPRs system had both advantages and disadvantages. Arguments related to IPRs and technology diffusion demonstrated that the relation between IPRs and technology diffusion in a country was not straightforward but dependent on different industries, channels and other policies. These factors should be considered while doing fieldwork. With research objectives and these important factors, this research defined the following fieldwork questions.

- Is Chinese IPRs protection reform obtained in the WTO accession detected by technological executives of Chinese firms?

This is a basic question. If IPRs reform could not have been detected by technological executives of Chinese firms, it would imply that IPRs reform in China did not have an impact on the processes of research, production or application related to technology. This would occur if China reformed IPRs regulations without strengthening the enforcement of IPRs regulations. Therefore, the first important question in this fieldwork should be to identify whether different selected technological executives detected the change of IPRs protection policy in China.

- What are the impacts of IPRs reform on domestic technology development and diffusion in China? Are there other factors that have an influence on the relation between IPRs and the development and diffusion of China's domestic technology?

Development and diffusion of domestic technology is part of the technology diffusion for a country. These questions explored the impact of IPRs protection reform on the development and diffusion of domestic technology in China, including positive and negative impacts. According to relevant arguments, the relation between IPRs and domestic technology development depends on other factors. Thus, whether other factors could have some influence and how they influence the relation between IPRs reform and the development and diffusion of China's domestic technology should be investigated in fieldwork. This fieldwork should pay more attention on the detailed expression by technological executives in each selected industries about their

experience on the impact of IPRs protection reform on domestic technology development in China. The general view about whether IPRs protection reform has positive or negative impact on domestic technology development in China should be collected. More importantly, more detailed examples about the impact of IPRs reform on domestic technology development and the reasons behind that should be explored and analysed. Previous literature searches found that other factors, such as different sectors had different impacts on the relation between IPRs protection and domestic technology development. Thus, fieldwork should test it and explore these specific factors in China and analyse the reasons for them.

- What are the impacts of IPRs reform on technology transfer from foreign countries to China? Are there other factors that influence the relationship between IPRs and technology transfer from foreign countries to China?

Technology transfer from foreign countries is another part of technology diffusion for a country. These questions investigated the positive and negative impact of IPRs reform on technology transfer from foreign countries to China as well as exploring whether other factors could affect and how they influence the relation between IPRs reform and technology transfer to China. This fieldwork should also pay attention to detailed impacts of IPRs protection reform on technology transfer in China. In order to achieve it, examples and reasons should be obtained from selected executives. It should also be valuable to compare the impact of IPRs protection reform on domestic technology development with that on technology transfer from foreign countries. This comparison could help to investigate which part receives more influence by stronger IPRs protection and analyse the reasons for it.

- Are there other policies that could have an impact on the relationship between IPRs protection reform and technology diffusion in China, and if yes, how?

According to relevant arguments, some researchers believe that other relevant policies affect the relation between IPRs protection and technology diffusion for a country.

These questions explored whether there are such policies and how these policies influence the relation between IPRs reform and technology diffusion in China. This question also comes from the previous literature. Obtaining detailed information about other policies related to promoting technology diffusion could help to understand the general policy background in China.

- What are the opinions of technological executives in Chinese firms on the current IPRs protection? Do they believe that the current IPRs policy is the best method for encouraging technology development and diffusion in China? What are the advantages and disadvantages of the current IPRs policy related to technology diffusion in China in the view of these technological executives? If they believe there are some disadvantages of the current IPRs policy, how do they deal with these disadvantages?

These questions were about the opinions of technological executives in Chinese firms on the current IPRs policy. Technological executives of Chinese firms involved in R&D, commercial production of technology and technology transfer from foreign countries. With direct experience of the impact of IPRs reform on technology diffusion in China, their opinions on the current IPRs policy are quite valuable and worth being researched. The advantages and disadvantages of current IPRs protection policy on technology diffusion expressed by technological executives could bring detailed and fire-new comprehension about current IPRs protection. If they notice some limitations of current IPRs policy, the method they applied to cope with these limitations may provide valuable alternative ways to reduce the disadvantages of current IPRs policy.

- Are there any official statistics or other sources that can provide information about the impact of IPRs reform on technology diffusion in China?

This question is about other sources that can provide information for this research. If yes, it would worth finding out and making them complementary to findings obtained from those technological executives. Any other sources beyond the design should be

valuable, because no one could have a perfect plan to collect all useful information and there is always some unexpected material that can provide useful information.

- Does any special or unique factor exist in China that can have an impact on the relation between IPRs reform and technology diffusion?

The aim of this question is to let the researcher pay more attention to some special and unique factors related to this research exist in China. Finding out and analysing these special factors would help to understand the impact of IPRs reform on technology diffusion in China. Moreover, these special and unique factors are also the important parts of the main contributions of this research.

These questions define purposes and tasks of the fieldwork. They also help to select suitable research methods in order to accomplish these purposes and tasks.

5.3. Research methods

According to the fieldwork questions, semi-structured interviews and self-completion questionnaires were selected as the main methods of the fieldwork. This research also collected relevant official statistics and other sources.

5.3.1. Semi-structured interview

Interview is a method for data collection in the social research area. The aim of the interview is to find out what is in someone else's mind (Patton, 1990:278). Interviews produce substantive insights into people's attitudes, experiences and feelings (May, 2001:120). There are individual interviews and "group interviews", and the most popular one is "individual, face-to-face verbal interchange", which is also the most familiar individual interviewing (Fontana and Frey, 1998:48). This research used semi-structured interviews, which mean that "the researcher has a list of questions or fairly specific topics to be covered, often referred to as an interview guide, but the interviewee has a great deal of leeway in how to reply" (Bryman, 2004:321). In

semi-structured interviews, an interview guide that can cover all necessary specific issues is prepared before the interview. During the interviews, the interviewer can change the sequence of the specific issues in the interview guide and questions that are not involved in the interview guide can be asked according to the situation.

The semi-structured interview was selected as a method for doing fieldwork for the following reasons. Firstly, there were no specific data or documents available on this research topic. Specific data needed to be collected from the technological executives of Chinese firms, who had experienced the impact of IPRs reform on technology diffusion in China directly. Interviews would help to find out their attitudes, experiences and feelings about this topic. The most useful information for this research could be gathered from individual firms that engaged in doing R&D and using technology. Although every one in China might have opinions about the impact of IPRs reform on technology diffusion, technological executives working in these firms should be the best choice to explore the influence of IPRs protection reform on innovative activities and the utilization of technology, as they were directly involved in R&D, commercial production of new technology, technology administration and so on, and hence would have detailed and direct experience and feelings about IPRs reform and technology diffusion in China. One may consider that participant observation is also a method to get direct attitudes, experiences and feelings of these technological executives. The aim of participant observation is to obtain close comprehension of a given group of individuals and their experiences and practices through closely involving in people's natural circumstances in a short period. It is possible and feasible to find out the experience and feelings of technological executives about the influence on activities related to technology diffusion in their firms by the change of IPRs protection. However, it is impossible to observe the exact behaviour of these technological executives related to technology diffusion in their firms and institutions, because technology is always a quite important, sensitive and confidential issue for each firm. Since each firm tried to keep the commercial negotiation, especially negotiation related to technology, secret, "an outsider" would not be allowed to attend the negotiation process. Moreover, the

process of technological improvement and diffusion developed by firms would require a long period of time and usually a researcher would not be allowed to participate. As a result, participant observation is not suitable for this research. Secondly, interviews could also help to recall and reconstruct things that occurred in the past (Bryman, 2004:339). Most Chinese IPRs reforms occurred during the period when China was trying to enter the WTO. Previous experience on technology diffusion in China needed to be reconstructed for this research. Interview is a suitable method to discover the impact of IPRs on technology diffusion before China reformed its IPRs policy. Thirdly, the semi-structured interview uses an interview guide to cover all necessary issues related to this research. One may suggest that structured interviews have the same function. A structured interview often uses very specific questions and provides the interviewee with a fixed range of answers. However, specific questions and fixed range of answers would limit the data collection of this research. Unknown and unexpected things brought up during the interview are valuable for investigation in detail. Semi-structured interviews allow the researcher to find out unexpected and unknown factors through changing the structure, the sequence of sentences and elicit words of interview questions (Gerson and Horowitz, 2002:201). In addition, semi-structured interviews can include open questions to encourage interviewees to do thick descriptions about relevant issues. Moreover, this research emphasizes individual interviewee's ideas and perspectives about the influence of IPRs reform on technology diffusion in China. The answer put forward by different interviewees cannot be standardized, thus, the structured interview is not suitable for this fieldwork. Finally, the semi-structured interviews are also suitable for different situations by changing the sequence and words of interview questions according to different contexts. In practice, many interviewees could not follow the original arrangement. Sometimes, interviewees' responses for one question involve many other important questions, which thoroughly broke the sequence of the interview guide. It is preferred to apply semi-structured interview, because it can deal with this situation with facility.

Although the semi-structured interview is suitable for doing this fieldwork, the limits of

this method are worthy of mention. Firstly, because the sequence and wording of different issues can be changed by the interviewer according to different situations, different interviewees may give different responses, which reduce "the comparability of responses" (Patton, 1990:288). This can be overcome by covering all issues in the interview guide during the interview, and carefully comparing and analysing each response. Secondly, with the attendance of researcher, anonymity is also reduced. This research involved information on R&D, technology development and diffusion. This information was quite sensitive as it was the core secret for these firms. Moreover, anonymity was particularly significant for this research as the Chinese government supported IPRs reform and the issue was also politically sensitive. This limitation could be overcome by promising anonymity before interview. In addition, this research also used self-completion questionnaires to collect data. Self-completion questionnaires allow selected technological executives to answer questions by themselves without the attendance of the researcher. Self-completion questionnaire increased anonymity, and data collected through interviews and questionnaires were also compared in this research.

5.3.2. Self-completion questionnaire

Self-completion questionnaires allow respondents to answer questions through accomplishing the questionnaire by themselves. Questionnaires are usually sent out by post to respondents. But this research used Internet as the medium to collect questionnaire data from respondents. The advantages of using the Internet as a questionnaire data collection method is that it can save time and money, reach a large number of individuals easily, and collect data quickly without considering the distance (Bryman, 2004:470). However, there are also limitations of using the Internet. Firstly, not everyone can get access to the Internet all the time. If the selected participants could not access the Internet for a certain period of time, they could not complete the questionnaire. This limitation was overcome by leaving plenty of time for selected technological executives to receive and complete the questionnaire. If there was no

response from the participants after the given time, the researcher would try to contact and arrange to have face-to-face questionnaire. Secondly, the email containing the questionnaire might be mistreated as a nuisance email. This could be avoided by providing clear subject for the email. Thirdly, because the researcher was not around to explain the meaning of the questions while completing the online questionnaire, some questions might not be answered. This could be resolved by carefully designing the questionnaire and adding functions to remind the participants when they omitted some questions.

There are some reasons for selecting self-completion questionnaires in this fieldwork. Firstly, this method could help to cover a large range of individuals in different geographical areas at a low cost. Since interviews could not be done with many people, self-completion questionnaires could offset this limit by reaching many individuals in a short time. Secondly, respondents completed this questionnaire by themselves with their own consideration, which reduced the biases created by the researcher in face-to-face interviews (May and Williams, 2001:98). Finally, this method could increase anonymity, which was particularly important for this research as the issue of the IPRs reform was politically sensitive in China. Considering that technology information was also sensitive and confidential to the Chinese firms involved in this research, anonymous self-completion questionnaires would be able to provide more real information to this research.

The self-completion questionnaires also have disadvantages. Firstly, if respondents experience difficulties while completing the questionnaire, they cannot get any help from the researcher. Therefore it is very important for the researcher to make sure that each question could be easily understood by respondents. Secondly, the self-completion questionnaire tends to have a low response rate (Bryman, 2004:135) and there is no control over the selected respondents in answering the questions carefully. Without supervision and prompting, some respondents may easily decide not to give answers to certain questions or not to answer the whole questionnaire at all. Therefore, it may be

necessary to send out the questionnaire again to persuade selected respondents to answer the questionnaire carefully. Moreover, if there are a lot of questionnaires that are not completed, it is very important to try to make appointments with selected respondents. Thirdly, because there is no control over the process, it is possible that the person who answered the questionnaire is not the same one that has been selected. Technological executives in relevant firms are selected to complete the questionnaire, because of their experience and sufficient knowledge about this research topic. But it is possible that someone else, who does not have such qualities, would complete the questionnaire instead of the executives, and this would reduce the response accuracy. The reduction in accuracy could be overcome by comparing the data obtained from questionnaire with data obtained from interview and official statistics.

5.3.3. Official statistics and other sources

This research also collected data from relevant official statistics. Official statistics usually mean “data collected by the state and its agencies” (May, 2001:72). This method can reduce the cost and research time, as data is collected by others. (Bryman, 2004:202). It gives researchers more time to concentrate on the analysis of data. For this research, official statistics also allowed the researcher to do comparison between data obtained from interviews and questionnaire.

It was found that there were many different kinds of resource that could provide useful information for this research. Besides doing interviews, questionnaires and collecting official statistics, other sources, such as television programs, were also used to collect information. These different kinds of information were used as complements for interviews, questionnaires and the official statistics.

5.4. Fieldwork plan

Before going through the detailed fieldwork plan, it is necessary to explain some important factors about the field, which were obtained through piloting for interviews

and questionnaires. 1) Some technological executives of Chinese firms neither paid much attention to research nor wanted to accept interviews. At least, their reluctant attitude could be perceived from their manner of speaking. Their replies were either that they were busy or that they were not in charge of this issue and told the researcher to contact other relevant people. Even if these 'relevant people' could be reached, the same answers were given, and that they do not have the time for interviews. Therefore, it was known that they were not willing to be interviewed. Some interviewees were asked about reasons for them not willing to accept the interview. According to their answers, the main reasons were that they did not care about the research and that they also believed that this kind of research could not bring direct benefit to their firms. Some technological executives' unwillingness to accept research could also be seen from the result of questionnaires. At the time, six questionnaires were sent out by email to selected Chinese firms for doing piloting, but only one answered questionnaire was received. Moreover, this questionnaire was partially completed. Therefore, relevant executives were contacted to do piloting for face-to-face questionnaire in order to get completed answers to test the questionnaire. After finishing two piloting questionnaires, relevant participants were asked about the reasons for not being willing to accept interviews or questionnaires. They replied that executives of Chinese firms did not care about research, such as interviews and questionnaires. If the questionnaire could be completed by clicking from options provided, they might be willing to do it because the questions would be easy to answer. They also indicated that open questions in the questionnaire might not receive any response, because technological executives would not waste their time and energy to write answers. 2) Personal connections were an important factor for accomplishing this fieldwork. This was not considered before carrying out the fieldwork lest it should affect the objectivity of the research result. However, after trying to contact some technological executives for interviews and questionnaires as a piloting job, it was found that it would be difficult to be accepted by these executives without personal connections. Nevertheless, it also showed that the use of personal connections did not affect the objectivity of fieldwork result, because it only played the role of an introducer and did not involve the concrete content of this

fieldwork. Furthermore, personal connections also helped to establish a good atmosphere so that interviews and questionnaires were accomplished smoothly. 3) These technological executives did not know detailed IPRs protection policy quite as well as expected. People in charge of applying patent, copyright, trademark and other kinds of specific items of IPRs protection, comprehended IPRs protection policy commendably. However, only these technological executives had the authority to make decisions on developing, transferring and purchasing a kind of technology. Moreover, it was these technological executives who knew the relation between the cost and the benefit of developing a kind of technology, rather than the people who were in charge of applying specific items of IPRs protection. These findings could be seen from the following which is part of transcription of the 1st interview with a technological executive of a stated-owned chemical firm.

> *Question: Do you know about IPRs protection policy, especially the IPRs protection policy in China?*
> *Answer: Yes, I know some of it. IPRs protection policy is very important for my company. It was introduced from western countries to China. China's IPRs protection policy is not very good. China's IPRs protection policy only started from the "Open Door" Policy, especially from the 1980s-1990s. In China, it has become stronger in these last few years. However, it is still not as good as that of western countries. The IPRs protection policy in western countries can provide very good protection for technology. China's IPRs protection policy is waiting for further development. Certainly, I only have general knowledge of the policy on IPRs protection. My company has a special department that is in charge of applying for patents, copyrights and trademarks. Staffs in that department know the IPRs protection policy very well, because it is their job. If you want to have detailed information, I can introduce you to one of these staffs.*
> *Question: Thank you very much. Can you tell me whether these staffs in charge of applying for patents, copyrights and trademarks, can also get involved in the decision-making about technology in your firms?*
> *Answer: These staffs do not take part in the decision-making about the company's important issues, such as developing a particular technology. But they can report some important changes on IPRs policy to the manager. The important issues in this company are decided through discussion among managers and executives of different departments. The main job of these specialist staffs is to apply for patents and so on.*

This part of an interview transcription shows that staff in charge of applying patent and copyright, grasped detailed information about IPRs protection policy. They had the responsibility to report important changes on IPRs protection policy, but do not directly participated in the decision-making on developing technology. Technological executives took part in the decision-making about developing technology but they only had some general knowledge of IPRs policy in China. Considering this finding, it was better to ask these executives questions about the detailed impact of IPRs reform on technology development and diffusion in their firms, rather than particular questions about detailed IPRs protection policy. 4) Because this research project involved questions about a firm's basic conditions, technology, patent, and even the attitude of a firm's technological executive on IPRs protection policy, which were most sensitive, participants, sometimes, gave very blurry answers. For instance, when the researcher asked about the number of patents held by the firms, some participants only gave a rough number rather than a precise number. Thus, the researcher needed to probe more response when doing interviews. The fieldwork summary and detailed fieldwork process are shown in Appendix three and four.

5.4.1. Semi-structured interview

This research did interviews with the technological executives of some Chinese firms. These firms has a long enough history to cover the period before and after the change of IPRs protection in China. This research applied "purposive sampling" strategy (Patton 1990:181). Purposive sampling means selecting "information-rich cases", which refer to cases from which one can get a lot of information about his/her research issues (Patton 1990:169). There are many different strategies for purposive sampling. As discussed earlier, many researchers found that the relation between IPRs protection and technology diffusion depended on other factors. Among these other factors, the most important one is the difference in industries. For example, Mansfield (1986) found that the pharmaceutical and chemical industries were most sensitive to patents; petroleum, machinery and fabricated metal products and most engineering industries were

moderately sensitive to patent protection; and office equipment, motor vehicles, rubber and textiles industries were quite a lot less sensitive to patent protection. For copyright, the software and publishing industries were the main areas to be influenced by IPRs protection. According to this analysis, this research used stratified purposive sampling, which means selecting "above average, average and below average cases" (Patton 1990:174). For patents, samples for semi-structured interviews were stratified. This research selected firms from pharmaceuticals and chemicals industries that had above average sensitive relations with patents. It also selected firms from the petroleum, electronic, machinery, transportation equipment and primary metal industries that had average sensitivity toward patents. This research originally planed to select firms from rubber and textiles industries that had below average sensitivity toward patents. However, it was quite difficult to find technological executive in rubber firms to accept an interview. During interviews, I asked some selected technological executives about how to cope with this difficulty. Some technological executives said that there ere two types of food firms in China, one used many chemical factors in manufacturing, and another did not use chemical factors. Firms that produced milk powder and beverage are the former type. Because the main manufacturing process of this type of food firms was analysing and synthesizing chemical ingredients, these firms should be classified as chemical firms. Food firms producing cake, cooked food, and traditional snacks, which were also called the traditional food firms, were the latter type. These traditional food firms did not have a lot of technology therefore were not sensitive to patents. These traditional food firms, together with firms from the textile industry, which also had below average sensitivity to patents, were selected to replace the firms from rubber industry. And for copyright, the initial plan was to select firms from software and publishing industries. But when selected technological executives in publishing firms were contacted for interviews, the managers of these firms said that although the firms could obtain profit from publications, most of the profit from selling publications went to the authors themselves, and when pirated copies appeared in the market, the authors would lose more than the firms, and therefore, these authors paid more attention to IPRs protection than the firms. Since publishing firms paid less attention to IPRs protection

than authors, it was more suitable to interview authors to get information for this research. However, many famous authors were difficult to contact for interviews. Some managers of publishing firms suggested that government officials in departments that were in charge of the publishing industry would have more detailed information about IPRs protection and its relation with the diffusion of intellectual works in the publishing sector, as most authors turned to these departments for help when they encounter problems related to IPRs protection and these departments also supervised the transfer of publications from foreign countries to China. Thus, this fieldwork interviewed relevant government officials for information about IPRs protection and the diffusion of intellectual works in the publishing sector. For each selected interview industry, personal connection was used to introduce the researcher to a technological executive of one Chinese firm. Then the researcher asked the selected technological executives, who had accepted the interview, to introduce more relevant Chinese firms in their industries to the researcher to do more interviews in selected industries.

Semi-structured interviews are not suitable for large sizes of samples because of time and cost restrictions. In the practice, this fieldwork tried to take interviews with technological executives of all kinds of firms, including state-owned, private, big and small firms. The researcher did not stop interviewing technological executives until no new information appeared in each selected industry in order to be certain to get enough information about each selected industry.

This fieldwork used the general interview guide for semi-structured interviews. The general interview guide refers to setting up a series of topics, which will be mentioned to each interviewee, before interviews (Patton, 1990:280). Researchers do not need to make predetermined orders and elicit words for the listed topics and issues. The aim of the interview guide is to make sure that interviews cover all the necessary issues. Interviewers can change the sequence and words for each issue in the guide according to specific situation (Patton, 1990:280). It also leaves room for researchers to probe and ask follow-up questions during interviews (Patton, 1990:283). This fieldwork carefully

designed and explained the interview guide, which is shown in Appendix One.

Most semi-structured interviews were done through contact with selected individuals and face-to-face interviews. The use of a recorder was allowed in some interviews. But because there were questions about technology of individual firms, some interviewees did not agree to use a recorder. In addition, some selected individuals had no time for a face-to-face interview but accepted a telephone interview. Telephone interviews are cheaper than face-to-face interviews, and save the travelling time (Bryman, 2004:114-116). However, telephone interviews also have some limitations. 1) People who do not have telephones or are not contacted by telephone cannot be interviewed by telephone (Bryman, 2004:114-116). 2) The interviewees with hearing impairments will have difficulties in doing telephone interviews (Bryman, 2004:114-116). These did not apply to this research, because the interviewees were contacted in advance to make sure they could be interviewed by telephone in a certain period. 3) It may be more difficult to make sure whether it is the selected individual to answering the questions in the telephone interview, because the researcher cannot see the interviewees during the telephone interview (Bryman, 2004:114-116). Selected individuals were contacted in advance and met face to face through personal connections, before telephone interviews were carried out, to make sure that they would answer the questions during the interviews. These measures helped to make sure that the selected individual to answer the questions was doing the telephone interview. 4) The length of telephone interview is much shorter than a personal interview (Bryman, 2004:114-116). The interviewer of this research arranged the telephone interviews in the time when the interviewees were free for a long period to leave enough time for the telephone interview but these were still shorter than personal interviews. Therefore, the interviewer put extra effort on probing more answers in the telephone interview. 5) Telephone interviewers sometimes have difficulties in coping with signs of puzzlement and unease, which cannot be seen over the telephone. (Bryman, 2004:114-116). The interviewer of this research announced that the interviewees were free to tell their puzzlements and difficulties on the telephone before doing telephone interviews. Moreover, the interviewer paid more attention on the

tone of interviewees in order to judge whether interviewees faced puzzlements and difficulties during telephone interviews. The detailed interview list is shown in Appendix five.

Table 1 Summary of interviews

Industrial sectors	Number of interviews: total 38			
	Big firm	Medium firm	Small firm	Total
Pharmaceutical sector	1	1	1	3
Chemical sector	1	1	2	4
Petroleum sector	3	0	0	3
Electronic sector	1	0	2	3
Machinery sector	1	1	2	4
Primary metal sector	2	0	2	4
Transportation equipment sector	2	0	1	3
Traditional food sector	0	0	4	4
Textile sector	0	0	5	5
Software sector	1	1	1	3
Publishing sector	2 interviews with 2 governmental officers			2

5.4.2. Self-completion questionnaire

These self-completion questionnaires also used stratified purposive sampling. For patents, this research selected firms from pharmaceuticals and chemicals industries that had above average sensitivity toward patents, firms from electronic, machinery, transportation equipment and primary metal industries that had average sensitivity toward patents, and firms from traditional food and textiles industries that had below average sensitivity. Questionnaires were not given to the petroleum sector. There were only three big state-owned firms in this sector and other firms were subsidiary companies of them. Enough and detailed information had been obtained from interviews with technological executives in the petroleum sector, so questionnaires were

not necessary. For copyright, firms from the software industry were selected. Because enough information had been obtained from interviews with government officials who were in charge of publishing sectors and it was very difficult to get feedback from famous authors for questionnaire, this research did not do questionnaires in publishing sectors.

The sample size was comparatively large for questionnaires. However, because the low feedback rate of the self-completion questionnaire in this research, some questionnaires were done face-to-face. So, the sample size of this research was not very large considering the workload. This research planed to collect a minimum of 12 questionnaires in 9 different industries. Questionnaires in each selected industry also covered firms of different legal status and size. The researcher did not stop doing questionnaires until the planed minimum questionnaires were reached. It should be mentioned that the technological executives did questionnaires were totally different with those that received interviews in this research to avoid double counting of data.

The self-completion questionnaires were designed carefully, and are shown in Appendix Two. Doing piloting for this designed self-completion questionnaire was also quite significant. Doing pilot means to find out a sample related to this research to complete a questionnaire before sending the questionnaire to the whole sample. It is quite important for self-completion questionnaire to make sure all the questions work well, because there is no researcher to explain any confusion that appears in the questionnaire (Bryman, 2004:159). After piloting, if it was necessary, some of the questions in questionnaire were revised according to best practice.

Because this research used the Internet as the medium to collect questionnaire data from selected firms, the questionnaire was transferred into an electronic format. These questionnaires were sent out to selected firms by e-mail. The selected participants were provided with a couple of weeks of time to respond. After the given deadline, the same questionnaires were sent out again to those who had not responded, as a reminder. However, a couple of weeks after the questionnaires being sent out the second time,

there were only a few completed online questionnaires were received. Not surprisingly, according to the information obtained from piloting, it was shown that some of these technological executives do not want to waste their time to fill in questionnaires. Since it was difficult to get enough information by sending questionnaires by emails, there was a need to contact the selected technological executives and make appointment for face-to-face questionnaires in order to get enough response. This had undoubtedly increased the workload.

Table 2 Summary of questionnaires

I: Internet Questionnaire; F: Face-to-face Questionnaire

Industrial sectors	Number of questionnaires: total 108						
	Big firm		Medium firm		Small firm		Total
	I	F	I	F	I	F	
Pharmaceutical sector	3	1	2	2	0	4	12
Chemical sector	3	1	1	3	0	4	12
Electronic sector	6	0			1	5	12
Machinery sector	1	3	1	3	1	3	12
Primary metal sector	2	4			0	6	12
Transportation equipment sector	3	3			2	4	12
Traditional food sector					1	11	12
Textile sector					0	12	12
Software sector	4	0	4	0	1	3	12

5.4.3. Official statistics and other sources

This research also planed to get some official statistics from relevant departments of the Chinese government. These relevant departments are located in Beijing, and the most important one is the National Bureau of Statistics of China. This fieldwork obtained the following official statistics.

- Research and development expenditure

Research and development expenditure helped to show whether IPRs protection reform in China had influence on the expenditure on R&D. Because R&D is closely related to technological development, the expenditure on R&D is quite important for this research.

- Patent applications by residents and non-residents

Patent applications by residents and non-residents were used to indicate whether IPRs protection reform had an impact on patent applications by Chinese residents and by foreigners in China.

- Royalty and license fees payments and receipts

This research originally planed to get official statistics about the amount of technology transferred from foreign countries and the data about the cost of Chinese firms of getting technology from foreign countries, because these would prove whether IPRs reform could encourage more technology transfer to China and whether IPRs reform could lead to the increase of the price of foreign technology for China. But these were not available. However, there was the data about royalty and license fees payments and receipts in China in recent years. Although this could not show the number of technologies transferred from foreign countries, they illustrated whether China received more or paid more for royalty and license fees in recent years. Therefore, this data was collected.

During this fieldwork, the researcher also paid attention to all kinds of other sources. This research also collected information from television programmes and interviews with two government officials.

5.5. Difficulties in doing fieldwork

There were some difficulties for doing fieldwork in this research.

Firstly, this fieldwork was done in China. It was necessary to translate the interview guide and questionnaires into Chinese and then translate the response as well as data from official statistics and other sources into English. This caused some difficulties, because it was time-consuming and there were some words that could not be translated precisely.

Secondly, as discussed earlier, the topic of this research was comparatively politically sensitive. Some response might be influenced by the current political issues, and this reduced the accuracy of the data. This difficulty could be mitigated through probing during interviews. Allowing interviewees to explain more about their answers could help to find out their true opinions. Moreover, providing enough explanation about keeping anonymous was another method of getting true opinion from interviewees. This research also used self-completion questionnaire as a method to collect data, which could increase anonymity. Comparing interview data with questionnaire data could also reduce the inaccuracy.

Thirdly, this research included some questions that involved technological development and protection of each selected firm. This topic was very sensitive for all firms, because executives of these firms were concerned that their answers might give away their technological secret and trade secret. Although questions in this research did not involve specific technology of these firms or their secrets, some executives of these firms still did not want to accept interviews or to fill in questionnaires. This difficulty was mitigated through providing enough explanation about the interview questions and questionnaires. Keeping anonymity for each selected firm also helped to reduce this difficulty.

Fourthly, some interviews could not be recorded. Non-verbal signs and body language were not recorded. These problems could be resolved through making detailed interview notes. Some interviewees just gave very simple answers about questions. This difficulty could be reduced through probing more answers. Due to the limit of time and budget, interviews were restricted to small size and in a certain limited area. This research also

used the self-completion questionnaire method, which could offset the limitation created by interviews.

Finally, only a few responses for the Internet questionnaire were obtained. This makes face-to-face questionnaires individually necessary, added to the workload and extended the time for the fieldwork.

5.6. Conclusion

To conclude, this chapter introduces methodology and its rationality for this research. This research applied fieldwork to collect data. This chapter firstly analyses fieldwork questions in this research, then explores research methods selected for doing the fieldwork. Semi-structured interviews, self-completion questionnaires, and data collection from official statistics and other sources were used in the fieldwork. The reasons for using these methods and their limitations are analyzed. This chapter also provides a detailed fieldwork plan of this research. How to do interviews and questionnaires and how to collect information from official statistics and other sources are explained in detail. Finally, this chapter also analysed the difficulties in doing fieldwork for this research.

Chapter 6

Fieldwork data analyses

6.1. Introduction

After collecting the desired data from the fieldwork using the selected methods, this chapter presents the results of analysing different fieldwork data. This chapter introduces the process of analysing the semi-structured interview data and the self-completion questionnaire data, and summarises the analytical results of that data. The detailed data for analysing questionnaires are also provided, which are shown in Appendix six. This chapter also explains the analyses of official statistics and other material. This chapter only presents the fieldwork results. Theoretical analyses of the fieldwork results will be in the following chapter.

6.2. Analysing semi-structured interview

This part analyses the data obtained through semi-structured interview. The process of how to analyse semi-structured interviews is explained firstly, then the analytical results of semi-structured interview data is shown.

6.2.1. The process of analysing semi-structured interview

The first step was transcribing the interview into text. Interview record and field notes were used. The researcher did full transcriptions for 3 early interviews and did appropriate analyses of these early interviews. The researcher then found some guidance and important points to do the next transcription of interview records. Later, there was no need to do full transcriptions of interview record, and it was only necessary to transcribe sentences or words that were relevant to the guidance and important points

obtained from early analyses. Although there was no need to transcribe all sentences of the next interview record, the researcher still needed to listen to the whole record to make sure that the transcriptions covered all new significant points and information appeared in a later interview record. The second step was obtaining the main points and useful information through analysing each interview transcription. The third step was analysing interviews in each selected industry. In this step, the analytical results of each interview in one selected industry were compared to generalise the main points and useful information of each selected industry. The last step was comparing the similarities and differences among different selected industries to summarise the main points of different selected industries. The similarities were put together and differences were discussed separately.

6.2.2. Analytical results for semi-structured interview

Through analysing and comparing the semi-structured interviews in different selected industries, some main points were generalised: (a) feel of IPRs protection reform (b) sensitivity to IPRs protection policy; (c) positive impact of IPRs protection reform; (d) negative impact of IPRs protection reform; (e) impact of imitation on technology diffusion; (f) impact of other policies on technology diffusion; (g) opinions on IPRs protection reform.

Feel of IPRs protection reform

A technological executive of the 2nd interview with a big pharmaceutical firm said:

> *Certainly, we are aware of the changes in IPRs protection policy. IPRs protection policy is quite important for our production. We have a special department that deals with IPRs protection. The main work of its staff is to pay attention to the change of IPRs protection policy in order to provide guides for our production and planning.*

A technological executive of the 24th interview with a medium chemical firm said:

> *We have been concerned about IPRs protection for quite long time. We knew about IPRs protection even before there was good IPRs protection*

in our country. This was because we had contacts with foreign corporations before there is good IPRs protection in our country. At that time, our firm needed to obtain some foreign technology and foreign corporations that held the technology asked to us to accept their IPRs protection system in order to secure the benefit from their technologies. We could not have the technology we needed from them if we did not accept their conditions about IPRs protection. These foreign corporations were greatly concerned about IPRs protection, which led us to pay attention to this policy. Our firms set up a group to explore relevant policies on IPRs protection from that time. So, we paid attention to IPRs policy in China too. This let us know that China really made stronger IPRs protection in these years.

A technological executive of the 12th interview with a big petroleum firm said:

We did not realize that IPRs protection reform in China during the early period was making China's IPRs protection policy stronger. Because of in attention to this policy, our firm did something wrong, which led to us break of some Chinese IPRs protection regulations at that time. Our firm is a big state-owned firm in China. This had a very bad impact on our firm and even on our government. So, from that time, we paid more attention to IPRs protection policy in China. We know that IPRs protection in China has become better than before, although the enforcement is still not as good as that in the developed countries.

A technological executive of the 11th interview with a small electronic firm said:

We know that China reformed its IPRs protection policy during these years. Our industry is a technology-intensive industry in China. Our firm's products have a great need of good IPRs protection. We have to be concerned about it.

A technological executive of the 16th interview with a big machinery firm said:

We know about the reform of IPRs protection in China. This information could be obtained from newspapers, TV programs and websites, especially during the period of China's accession to the WTO and its negotiations with the USA. Moreover, this policy is important our firm. So, we are watching carefully changes in it.

A technological executive of the 34th interview with a big primary metal firm said:

We know that China implemented stronger IPRs protection policy in these years. Although our industry is not a technology-intensive industry, it is still very important to learn and know about the changes in IPRs protection policy in China. If you do not know about it, maybe someday you will break the law, which can bring great trouble to your firm. I have heard that this has happened in other firms in China. I do not want it to

happen to my firm.

A technological executive of the 19th interview with a small primary metal firm said:

> *We know about the reform of IPRs protection in China. Although there are just a few impacts on our firm by IPRs protection reform, we still know about the change, because the government has paid attention to it. The local government arranged managers and executives of different firms to learn about the change of IPRs protection in China in order to provide some guides for the operation of all kinds of firms. But I think it is quite useful for our firm, and it is worthy of being learned. At least, this knowledge can help our firm to avoid unnecessary losses.*

A technological executive of the 37th interview with a small transportation equipment firm said:

> *We know that China's IPRs protection has improved during these years. No only IPRs protection but also other regulations related to firm's operations in China have all become stricter and better. We have legal advisers in our firm to deal with all kinds of legal regulations related to the operation of our firm, such as contract terms and the protecting of our technology and advanced products. We have very good system in our firm to deal with these issues.*

A technological executive of the 26th interview with a small traditional food firm said:

> *Our industry has almost no need for IPRs protection policy. Our firm never uses it. We do not have significant technology to protect. But I know about the change. I care about political things and news. It is easy to get this kind of information from newspapers.*

A technological executive of the 31st interview with a small textile firm said:

> *We do not use IPRs protection. We do not have special technology; we just use handiwork for our production. We take little interest in the reform of IPRs in China. But I know about it; I know about it from China's Central Television program.*

A technological executive of the 22nd interview with a small software firm said:

> *We certainly know about the reform of IPRs protection policy in China. Every person who works in the software industry knows that the development of China's software industry is based on better protection for software. Without IPRs protection, software firms in China cannot get benefits from developing their software, because their products will be imitated by other firms too easily.*

These interviews indicated that technological executives of many kinds of Chinese firms in different selected sectors except the traditional food and the textile sectors felt that China had enforced stronger IPRs protection policy since the country tried to enter the WTO through their experience from their daily work. However, technological executives in the traditional food and the textile sectors could not perceive IPRs protection reform in their daily production. These sectors contained very limited technological factors. Firms in these two sectors mainly used handiwork for production, and as a result, technological executives of these firms did not feel the change of IPRs policy in their daily production. However, they learnt this from other channels, such as relevant policies published by the government.

Sensitivity to IPRs protection

A technological executive of the 3rd interview with a medium pharmaceutical firm said:

> *The technology applied in pharmaceutical firms, especially technology applied in western medicine, can be obtained easily through reverse engineering and research. Some western medicine made in foreign countries can be produced in Chinese pharmaceutical firms. Thus, if there are no restrictions through IPRs protection policy, our firm can imitate some technology easily. Similarly, technology held by our firm can also be imitated by other firms. Therefore, we pay more attention to IPRs protection.*

A technological executive of the 7th interview with a small chemical firm said:

> *IPRs protection is very important for the chemical industry. Each update of a chemical product can have its IPRs protection. It is easy to get the technology through analysing the products. If there is no IPRs protection, the technology developed by a firm can be easily obtained by its competitors. So, IPRs protection is very important for us. Our firm is a small firm and holds limited technology. Sometimes, our firm can still obtain technology from big firms through imitation. Certainly, we need to do it in very secret way to avoid being noticed by big firms with stronger IPRs protection. Big firms hold many technologies, and they do not want other firms to get their technology. So, they pay more attention on IPRs.*

A technological executive of the 27th interview with a big petroleum firm said:

> *Our firm is a state-owned firm and we have to implement the policies and regulations published by the government. There are three petroleum*

firms and all of us are state-owned firms. But we have separate administrative systems and technology is quite important for all of us. The one that obtains the technology first can get patent protection for the technology and can use the technology exclusively. Only if the technology is crucial for the government, will the government let these three firms share the technology. Otherwise, we can have our own technology. The one who owns the technology can take advantage of it and earn profit from it. Moreover, our industry is a technology-intensive industry. So, technology is very important for us and the protection of technology is also important for us.

A technological executive of the 28th interview with a big electronic firm said:

The electronic industry is a relatively new industry in China and electronic productions are updated quickly through the development of new technologies. Technology plays a very important role in this sector. IPRs protection provides direct protection of technology, so it has a significant impact for this sector.

A technological executive of the 25th interview with a small machinery firm said:

Our industry is not a technology-intensive industry. Not all new products in our industry can get IPRs protection. So, IPRs protection is not as important for us as for technology-intensive industries, such as the chemical industry. But IPRs protection, especially patents is not especially useful for our industry, but it is still useful. IPRs protection is especially useful for big firms in our industry, because they have more technology than small firms like us.

A technological executive of the 21st interview with a big primary metal firm said:

IPRs protection policy is useful for our industry, especially for the big firms in it. More technology means more competitive abilities. Our firm is also trying to develop new technology. However, our industry contains fewer technologies compared with technology-intensive industries, such as the pharmaceutical and electronic industries.

A technological executive of the 37th interview with a small transportation equipment firm said:

IPRs protection policy has important of our firm's production. To be honest, our firm is a small firm. We do not have many technologies. Most of our technologies are obtained by absorbing or imitating technologies from big firms. Since the government improved IPRs protection regulation, we have not dared to direct copy technology from big firms,

because we worry about being sued by the government and being punished by fines. We have to imitate in a very secret way in order to avoid being found by big firms and the government. So, although our industry does not contain many technologies, IPRs protection is still important for the production in our industry.

A technological executive of the 29th interview with a small traditional food firm said:

IPRs protection, especially patent has no relation with our firm. Our firms just used trademark in IPRs protection. The production process is kept in secret and it is not useful to apply patent.

A technological executive of the 38th interview with a small textile firm said:

Our industry is a labour-intensive industry. There is few technology in our industry. IPRs protection is not useful in our firm.

A government official of the 14th interview said:

In the publishing sector, authors of all kinds of publications now pay more attention to copyright protection. Authors care about two parts related to copyrights protection. The first one is their reputation, which is related to the onymous right in copyright. The second one is the benefit earned from their publications, which is guaranteed by copyright and earned through the sale of original publications. However, in recent years, there have been some authors, who just wanted to get a good reputation. They did not care about their benefits, and some of them even publish their works at their own cost. These authors do not care whether the copies sold on the market are original or pirated. The only concern for them is to make their names famous. Managers of publishing firms also know that China has reformed its IPRs protection. These managers mostly care more about the financial return from their publications. Our department also did investigations on the impact of IPRs protection on consumers of all kinds of publications. According to them, consumers know that China has reformed its IPRs protection through government propaganda and the relevant measures taken by the government to stop pirating. However, most consumers care more about the price of publications. As long as the quality of publication does not change greatly, consumers will buy the cheaper product and they will not care whether the product is original or pirated.

A technological executive of the 17th interview with a medium software firm said:

IPRs protection, especially copyright, is very important for our industry.

The change of IPRs protection has a direct impact on the production plan of our firm. So, we take this policy very seriously.

These interviews showed that different industries had different sensitivities to IPRs protection. Firms in pharmaceutical, chemical, petroleum and electronic sectors were highly sensitive to IPRs protection, while firms in machinery, primary metals and transportation equipment sectors were less so sensitive to IPRs protection, and firms in the traditional food and the textile sectors took little interest. The publishing and the software sectors had involvement with copyright in IPRs protection. Moreover, IPRs reform had great significance for technology development and diffusion in software firms.

Technological executives of selected Chinese firms explained the reasons for their different sensitivities to IPRs protection. Pharmaceutical, chemical, petroleum and electronic sectors contained relative high degree of scientific and technological factors. Technology in these sectors was easier to copy compared to other sectors. Moreover, almost every new product in these sectors contained special technology that could justify a patent. Therefore, these sectors were quite sensitive to IPRs protection. Machinery, the primary metals and the transportation equipment sectors were medium sensitive to IPRs policy. Because these sectors did not contain quite as many scientific and technological factors, the change of IPRs protection had less impact on technology development and diffusion in these sectors. This did not mean that technological executives of these three sectors considered that their firms did not contain any technological factors nor did they believe that the change of IPRs protection had no impact on technology development or diffusion in these sectors. This only meant that these sectors had comparatively less scientific and technological factors compared to the pharmaceutical, chemical, petroleum and electronic sectors; and technological executives of these sectors considered that IPRs reform had relatively less influence on technology development and diffusion in their firms. This was generalized through comparing interview transcriptions of technological executives in the first group of sectors with that of in the second group of sectors. During interviews almost all the

technological executives from the pharmaceutical, chemical, petroleum and electronic sectors said that these sectors were high technological industrial sectors and IPRs protection, especially patent, was quite important to these sectors. Whereas, most of the technological executives in the machinery, primary metals and transportation equipment sectors said that these sectors contained some technologies but not with high technological density. They also believed that China's IPRs reform did have impacts on technology diffusion in these sectors, but the impact was comparatively less than it was in the pharmaceutical, chemical, petroleum and electronic sectors. Some of them explained the reasons for this difference. Almost every new product in pharmaceutical, chemical, petroleum and electronic sectors had its own special technology, which could be protected by a patent. However, only very important products and crucial technological improvement in machinery, primary metals and transportation equipment sectors contain technology that could be protected by patent, and most products in machinery, primary metals and transportation equipment sectors only contained very limited technological improvement, which could not obtain patent protection. The manufacturing level of mechanics played very important role in machinery, primary metals and transportation equipment sectors. This was different from those in developed countries, because the technological level of these sectors in China was quite a lot lower than that of developed counties. The traditional food and the textile sectors hold very limited technology, thus these two sectors are least sensitive to IPRs policy.

Moreover, big and state-owned firms were more sensitive to IPRs policy than small and private firms in China. State-owned firms were controlled by the government and big firms drew a lot of attention from the government. Therefore, these firms did not dare to break IPRs regulations published by the government. Interview data also showed that most of the big firms were state-owned firms. Small and private firms did not receive as much attention as big and state-owned firms, and these firms might break IPRs regulation without being noticed by the government. Interview data indicated that most small firms were private firms. In addition, since state-owned firms were supported by the government and had more resources than small firms, after China reformed its IPRs

policy and provided more guarantee for getting profit from new technology, state-owned firms and big firms were able to put more into R&D than small and private firms. Just as a technological executive in 11th small pharmaceutical firm said:

> *I know that stronger IPRs protection can give more opportunities for my firm to benefit from new technology. But developing new technology requires more resources, and my firm cannot afford it sometimes. My firm cannot compete with the state-owned firms. The state-owned firms can get money from the government if they find it necessary to develop a particular technology. My firm cannot compete with the big firms, because they have more money than us. So, I need to think about the strength of my firm all along.*

Positive impact of IPRs protection reform

A technological executive of the 2nd interview with a big pharmaceutical firm said:

> *During these years, our firm has spent more on R&D. The technology developed by our firm and the number of patents obtained by our firm have both increased in these years. The technological capability of our firm has increased. I think these are strongly related to the improvement of IPRs protection regulations. With IPRs protection becoming better, we gradually notice that developing new technology can bring great benefit for our firms.*
> *Certainly, the contact between our firm and foreign firms has also increased during these years. However, because we had contacts with foreign firms long before and the foreign firms always asked for IPRs protection for their products, there is no obvious impact by IPRs protection reform on the contact between our firm with foreign firms. Foreign firms always pay attention to IPRs protection. Technology in Chinese firms is quite compared to that in foreign firms and foreign firms can use the contract terms to ask for IPRs protection for their technology, so although IPRs protection in our country was not good before, foreign firms still had business with firms in our country. Certainly, foreign firms hope there is good IPRs protection in our country. But earning money is most important for foreign firms, and if the business can earn money for foreign firms, they will do it. Our country has a very big market, and foreign firms will earn money here, so they want to do business in our country,*

A technological executive of the 1st interview with a big chemical firm said:

For technology development in our country, I think the reform of IPRs protection has had a positive impact. During these years, we developed more and more technology. If there is no IPRs protection, the benefit of developing new technology cannot be ensured. Our firm is unwilling to do things that only have inputs but do not give back some benefit.
For obtaining technology from foreign firms, IPRs protection has some positive impacts. Because IPRs protection policy is a fact of the investment environment in our country, good IPRs protection means a good investment environment. Foreign firms are more willing to have contact with us, through FDI, selling equipments and high-tech products, selling technology to us, and so on. But the impact on obtaining technology from foreign firms is not particularly obvious, because we had contact with foreign firms long ago and our firm started to accept the IPRs protection required by foreign firms ago. We had to follow the requirements on IPRs protection put forward by foreign firms when we negotiated technology transfers with them even before China reinforced its IPRs protection. If we did not accept their requirements, we then could not get their technologies. We had no other choice, because they had the technologies we needed and they had the right to make their decisions.

A technological executive of the 13th interview with a big petroleum firm said:

I believe that China's IPRs protection policy developed very fast and faster than any other country in the world. I am the person who deals with IPRs protection in our firm, so I know it very well. Stronger IPRs protection directly encouraged technology development in our industry. There is a great positive impact by stronger IPRs protection on technology development in our industry and also in the whole country, I think. The protective awareness of firms in our industry has been increased in these years. In the past, there were great losses because of we did not have IPRs protection. But now, things are better, and we can get great benefit from developing technology because we have an IPRs protection policy. So, R&D input in our firm has gradually increased during these years. But, as for obtain technology from foreign countries, IPRs protection does not have positive impact. Foreign firms and government always try to control and block petroleum technology in China, because petroleum is a very important and limited energy product. So, I think the fact that foreign countries do not want to transfer their technology to China is not due to IPRs protection, but due to some political reasons, such as foreign countries do not want to see that China could have competitive abilities in this sector. So, whether China has good IPRs protection or not, foreign countries still do not want to transfer technology to China.

A technological executive of the 35th interview with a small electronic firm said:

I think IPRs protection is useful and has a positive impact on technology development in our firm and even in our country. This because of

relevant IPRs regulations, firms can get benefits from developing new technology. In the past, without IPRs protection, all kinds of innovations belonged to the government, so the person or the firm who developed the technology could not get any benefit except limited rewards from the government. Now, things are quite different. We can get great benefits from R&D. So, our firm is putting more money on R&D and the training of its staffs. Our firm also uses a lot of money to hire persons with high-tech ability. But I think better IPRs protection has limited positive impact on obtaining technology from foreign firms, except that it has improved the investment condition in our country. This is because those foreign firms always pay attention to IPRs protection and they asked for IPRs protection through terms in contracts with firms in our country even before China had better IPRs protection.

A technological executive of the 32nd interview with a small machinery firm said:

I think that IPRs improvement has had a positive impact on technology development in our industry and in our country. Our firm also realises that based on stronger IPRs protection, great benefit can be obtained from doing R&D and new technology. However, our firm is a small-sized firm in this sector and it does not have ability to do R&D. Our firm tried to develop new technology the year before last, but we failed to do it, because it needed so much money that we could not afford it. So, the positive impact of IPRs protection in our firm is not obvious. Production in our firm mostly uses old technology or imitates some technology from big firms in our sector. But we now have to make the imitation very secretly to avoid being found out by big firms or being fined by the government.

A technological executive of the 20th interview with a small primary metal firm said:

I think IPRs protection has had a positive impact on technology development in our country. In the past, whether you held new technology or not, you obtained similar benefits from production, because most technologies were not protected by IPRs and many firms used imitated technology. Now, with better IPRs protection, if one firm has new technology, this firm can get much more benefit than firms that do not have that technology. The reason for the slow development of our firm is that our firm did not grasp the opportunity to develop new technology. Certainly, lacking enough money is another important reason. Although the level of production in our firm is higher than that in the past, in general, our firm mostly uses old or imitated technology obtained from big firms and the increase in the productive level is due the improvement in productive level in the whole industry. Some firms in our industry grasped the opportunity and they input money to develop new technology and new projects, so these firms developed very fast.

A technological executive of the 4th interview with a big transportation equipment firm said:

> *Better IPRs protection has had a great positive impact on technology development. In the past, we could obtain technologies through imitation from others and even some foreign countries. Moreover, our firm had to share our technology with other firms in our industry. Our firm even needed to help other firms to set up their production lines through providing them our technology and our technicians. So, in the past, developing technology could not bring direct benefit for a firm. Now, owing technology means owning a great competitive ability and earning great benefit. So we input more on R&D.*
> *I think better IPRs protection does not have an obviously positive impact on obtaining technology from foreign firms, because our firm could obtain technology from foreign firms before there was good IPRs protection if we accepted their requirements. Foreign firms listed IPRs protection in their contracts with our firm. We had to accept that.*
> *Big firms and state-owned firms like our firm dare not imitate any more. If we imitate again, we will infringe the IPRs of other firms. The compensation in this kind of cases is very big and the government will also make us to pay the fine for it. Certainly, some small and private firms still dare to imitate technology because they want to earn money in a short period without great inputs. Some of our technology was imitated by some small firms in the past. We did not ask for compensation from these small firms, because they are quite small and the impact of this imitation was not great for our firm.*

A technological executive of the 4th interview with a small traditional food firm said:

> *Our firm does not use IPRs protection. Our firm uses secrecy. Some important technology is strictly controlled by some important staff members. The technology is obtained through the accumulation of productive experience over very long time. So, the change of IPRs protection has not had any impact on our firm.*

A technological executive of the 5th interview with a small textile firm said:

> *Our firm does use IPRs protection. Our firm does not have special technology. Our sector is a labour-intensive sector. All firms in our sector use similar productive handiwork. The only difference among different firms in our sector is the application of different machines. If you use good machines, you can produce high-grade products. Our firm can produce any textile products that appear in the market, if it is*

possible with our machines. There is no special technology in our sector. So, IPRs protection does not have any impact on our firm.

A government official of the 15th interview said:

Although the enforcement of IPRs protection policy in China is not as good as that in foreign countries, there is great reduction in copied publications in our country. In general, with the improvement in IPRs protection policy in our country, original publications produced by Chinese residents and transferred from foreign countries has increased and pirated publications appearing in market is decreasing.

A technological executive of the 18th interview with a big software firm said:

The IPRs protection policy is very important for our sector. Without IPRs protection and great improvements in IPRs protection policy, the software industry cannot achieve fast development in our country. Our firm pays close attention to using IPRs to protect our software. Certainly, the input on R&D in our firm is increasing now. And we are obtaining more technology in these years.

These interviews showed that domestic technologies developed by Chinese firms increased in pharmaceutical, chemical, electronic, machinery, primary metals, transportation equipment and software sectors, after China reformed its IPRs policy. This was indicated by the increase of investment on R&D by Chinese firms in these sectors and the increase in the amount of technology developed by Chinese firms in these sectors.

According to the selected technological executives in the pharmaceutical, chemical, electronic, machinery, primary metals, transportation equipment and software sectors, the legal channels of technology transfer included international trade, FDI, licensing and cooperation in R&D with foreign firms. In the interviews, these executives said that international trade, especially inward international trade in high technology products did bring foreign technology to China. They said that after advanced machines were purchased from foreign firms, a couple of staff was usually sent from these firms to help Chinese workers to learn how to use and maintain the machines. In this process, Chinese workers would grasp some technological information, which was key to

learning about the technology held in these machines. FDI could also transfer technology from foreign countries to China. Some foreign firms directly invested in China and set up a separate foreign capital firm. In this process, Chinese workers hired by the separate foreign capital firm could also gain technological knowledge from their daily work. Some foreign firms directly invested in a Chinese firm through cooperation. During this process, their Chinese partners could obtain technologies brought by these foreign firms. However, the increase of technology transfer from foreign countries through legal channels was less than that of domestic technology development by local firms in these sectors. According to the interviewees, stronger IPRs protection policy ensured benefit from new technology development. Nevertheless, the number of researchers and the capacity of doing R&D in China were both increasing. Under stronger IPRs protection, Chinese firms were also more willing to invest in R&D. Thus, the technology developed by Chinese firms in these sectors obviously increase after the country reformed its IPRs protection. Technological executives said that the increase in technology transfer from foreign countries through legal channels in these sectors was less than the increase of domestic technology developed by local firms in these sectors. The reason for this was that before China reformed IPRs policy, the process of technology transfer from foreign countries through legal channels had already followed IPRs protection as regulated in foreign countries, especially in the developed countries, at the time. Applying IPRs protection as regulated in foreign countries for technology transfer through legal channels was required by these foreign firms, technology would not be transferred if Chinese firms did not meet this contractual requirement. Due to the fact that Chinese firms engaged in transferring foreign technology through legal channels started to apply foreign IPRs policy according to the requirements of the foreign firms, China's IPRs reform had a comparatively low impact on them. However, China's IPRs reform changed its IPRs protection environment, which still had some positive impact on technology transfer through legal channels. Before China reformed its IPRs policy, even if Chinese firms had followed foreign IPRs policy for technology transfer, foreign firms were still reluctant to transfer technology to Chinese firms through legal channels, because the environment for IPRs protection at that time was

poor in China. After the country reformed IPRs policy, this had improved. Under the better investment environment with good IPRs protection, foreign firms became more willing to transfer their technologies to China through legal channels. Therefore, technology transfer from foreign countries to China through legal channels in these sectors still had some increase, although not as much as that on domestic technology developed by local firms in these sectors.

However, IPRs protection reform brought positive impact in the petroleum sector differently. The amount of technology developed by Chinese firms in the petroleum sector increased greatly after the country reformed its IPRs policy. It was necessary to explain the current situation of petroleum firms in China. According to the technological executives in petroleum sector, there were three main petroleum firms in China, which were all state-owned firms because petroleum is a very significant product for national safety. These three petroleum firms had many different subsidiary companies. In order to encourage the development of these three firms, the government encouraged the competition among them. Each state-owned petroleum firm had its own self-governing administrative system. Therefore, different petroleum firms could keep their own technology, except very crucial technology that was needed by the country in a very pressing period. Since there was no good protection for new technology before China reformed IPRs policy, technology developed by one petroleum firm was soon learnt by the other two petroleum firms. After China reformed IPRs policy, petroleum firms could get patent protection for their technologies, which could prevent technology sharing by other firms and ensured great benefit from developing new technology. Consequently, petroleum firms started to input more in R&D and the amount of technology developed by Chinese petroleum firms began to increase greatly. However, the stronger IPRs protection policy did not influence the technology transfer from foreign countries as much in this sector. Technological executives in petroleum said that since petroleum was an important and limited energy source and very important for the nation's security and people's livelihood, petroleum technology was strictly controlled by firms and governments, as it directly decided whether a firm and a country could own and abstract

more petroleum. They also said that China had a different ideology from foreign countries, especially the developed countries that hold many petroleum technologies. It was very difficult to transfer technology from foreign countries to Chinese petroleum firms even after the reform of the IPRs protection. Chinese petroleum firms could only get very basic petroleum technology from foreign countries, especially from western countries, because crucial technologies were kept secret by foreign firms and their governments and sometimes these firms did not apply for patent protection for their petroleum technologies.

The amount of technology developed by Chinese firms and the amount of technology transferred from foreign countries in the traditional food and the textile sectors did not increase greatly after the country reformed IPRs policy, because the density of technology in these two sectors was quite low.

In the publishing sector, the number of original publications increased and the number of pirated publications decreased in China after the reform of the IPRs policy. In addition, the number of all kinds of publications from foreign countries rose.

Different kinds of Chinese firms acted differently after China reformed its IPRs policy. Before the reform, most big firms and state-owned firms obtained technology mainly through their own research, licensing and imitation. After the reform, these firms did not obtain technology through imitation any more. Before the reform, most of the medium and small firms, which were mainly private firms, did not carry out their own R&D. Imitation was the main method for these firms to get new technology at the time. After the reform, these firms started R&D by cooperating with colleges and institutes, since they did not have the facility to carry out R&D on their own. Subsequently, the rate of imitation by most of these medium and small private firms decreased, although some of medium and small private firms still acquire technology through imitation. IPRs reform did not cause firms in the traditional food and the textile sectors to change their methods of obtaining technology. For firms in the traditional food sector, some of them had their own secrets in production, which were kept strictly by managers or executives or

owners of these firms. These firms did not rely on IPRs protection to protect their secrets. Some firms had their patented technology, but the number of patents held was quite small. Most of these food firms only hold one or two patented technologies. Even if some of the firms gained patents for their main technologies, they still treated it as strict secret in order to protect their technologies, because once these secrets were imitated by other firms, profits would be taken away greatly, which might threaten a firm's survival. Since these secrets were mainly gained from accumulation of productive experience, this was the main channel of getting productive secrets for the traditional food firms, regardless of China's reform of IPRs policy. For the textile sector, almost all firms use the same productive handiwork. The only difference among them was the application of different machines. Generally, firms in the textile sector did not have special technology. As long as a marketable product could be produced using their machines, firms could embark on producing it. If a new product was produced in one textile firm and came on the market, competitors could discover how to produce it by purchasing a sample product and embark on producing the same products. Therefore, whether China reformed IPRs protection or not, firms in this sector gained production methods mainly through this channel.

Negative impact of IPRs protection reform

A technological executive of the 2nd interview with a big pharmaceutical firm said:

> *My firm uses some patented technologies for commercial. But some owners of the patented technologies do not allow commercial production. Sometimes, even if owners of the patented technologies permitted the commercial production, the prices were so high that we could not afford it. We have to wait for the patents on the technologies to expire.*
> *Question: Did these phenomena occur before China implemented its stronger IPRs policy.*
> *Answer: No. Before the IPRs policy became stronger, no one wanted to obtain technology through legal methods, such as purchasing. Most firms tried to imitate new technology. Thus, if a firm wanted to buy a new innovation, the owner was very willing to sell it and the price was quite low. So, before China implemented stronger IPRs policy, technology was cheap.*

A technological executive of the 23rd interview with a small chemical firm said:

> *Some important technologies in our firm are kept secret now. These are held by a very limited number of staff, who are highly paid. Sometimes, when these staffs retire; our firm gives them large pensions in order to keep our technologies in secret.*

A technological executive of the 27th interview with a big petroleum firm said:

> *The effort devoted to preventing imitation by other firms in our firm is increasing gradually each year. Our firm has a well designed system to prevent technology imitation. We also have special software to administer all important information in our firm to prevent technology imitation.*

A technological executive of the 36th interview with a medium machinery firm said:

> *In the past, visiting and learning from one another were common and familiar activities among Chinese firms. Every Chinese firm was very willing to welcome personnel from other firms to visit and learn their advanced technology and administration. Nowadays, it is very difficult to visit other firms. Without permission, non-workers cannot enter the plant of other firms. Some firms have strict administrative regulations so that staff can only enter their owner's workshops. Our firm has this regulation. And the main purpose of it is to prevent technology from being copied by other firms. This kind of protective regulation is very useful. Some parts of our technologies indeed were imitated by another small firm, when the small firm hired one of our technicians using high salary 2 years ago. But because our firm had these protective regulations, this technician only know some small parts of our technology and this imitation did not cause great loss for our firm.*

A technological executive of the 10th interview with a big transportation equipment firm said:

> *Now, foreign firms put forward some strict terms when signing licensing contracts with our firm. Foreign firms ask us to use their raw materials and their special machines. If our firm wants to make improvement based on foreign technology, we must ask for engineers of the foreign firm to come to our plant and we must get permission from the foreign firm. Sometimes, we try to do some improvements on foreign technology without being noticed by foreign firms. But now, it is very difficult and we have to do it in very secret way, otherwise it can be noticed by the*

foreign firm and it can ask for great amount of compensation.

A government official of the 15th interview said:

> *Most ordinary people do not care whether the publications are original or pirated. They just care about the price and the quality of the publications. If the quality of copied publications is not too bad, they prefer to buy the pirated publications, because these are cheaper than the original publications. Sometimes, people cannot afford the price of original publications.*

A technological executive of the 18th interview with a big software firm said:

> *One of the characteristics of the software sector is that the speed of software update is very fast and almost all new software is developed from previous software. It was difficult to get current core software. Foreign software developers did not allow Chinese firms to develop new software based on their software. This has a great negative impact on the development of new software products.*

IPRs reform also had some negative impact for technology development and diffusion in China. Most technological executives, especially technological executives in big and state-owned firms, considered that stronger IPRs protection prevented technology diffusion through imitation. They said that it was difficult to imitate technology after China implemented stronger IPRs protection, and that big and state-owned firms did not dare to do imitation anymore.

Stronger IPRs protection ensured benefit from developing new technology, which encouraged many firms to use IPRs to protect their technology and made the importance of IPRs in protecting technology known. However, as discussed earlier, small and private firms could still get technology through imitation, because the government could not supervise all these firms. In order to preserve the benefit from developing new technology, many firms tried to get IPRs protection for their technology and took measures to prevent their patented technology from being imitated. Thus, Chinese firms in selected sectors also took measures and put more money into protecting their technology from pirating.

Some technological executives expressed a view that stronger IPRs protection provided the chance for their firms to delay the commercial production with the new technology and wait for better market conditions, as this may prevent the imitation of their new technology by other small firms. But they also pointed out that this delay also had a negative impact on technology diffusion, as their firms could not obtain relevant technological information from technological productions.

Some interviewees indicated that stronger IPRs protection also had a negative impact on developing new technologies and applying patented technology to commercial production. They said that sometimes their firms could do improvements based on patented technology. But the owners of the technologies did not want to sell the patented technologies or the prices were not affordable, then the improvements could not be accomplished.

Some interviewees said that nowadays important technologies, which could bring great profit, were strictly controlled by the firms that owned them. Although more technologies were transferred from foreign countries to China after its IPRs policy reform, most of these were basic technologies, whose development depended on further technology transfer from foreign firms, or were technologies which could not bring great benefit. Some technological executives said that their firms could not get the core technology transferred from foreign firms through different channels. They also expressed a view that without the core technology, even if the patent duration expires, their firms could not obtain the technology or do improvements based on the technology. Moreover, the price of obtaining technologies from their owners had been increased based on better IPRs protection. Some interviewees said that some foreign firms used some restrictive articles in the contracts, such as articles preventing technology development based on foreign technology, to protect their technology when transferring technology to China.

For the publishing and the software sectors, because Chinese people had low living standards and not every one could afford original publications or software, stronger

IPRs protection encumbered technology diffusion for ordinary people.

Impact of imitation on technology diffusion

A technological executive of the 6th interview with a small pharmaceutical firm said:

> *Even if our technology is obtained by other firms, our firm can still obtain benefit because we can put our products into the market earlier than other firms. But, our benefit will be reduced. In general, in most cases, we can get benefit from our new technology even if it is imitated by other firms.*
> *If there is no good IPRs protection, foreign firms will worry about the investment environment in our country. This may have some negative impact on obtaining technology from foreign firms. But foreign firms will consider the benefit first. If foreign firms can earn money, they will do business with our firm.*

A technological executive of the 1st interview with a big chemical firm said:

> *No new technology or no new product means no market for us. We have to develop new technology.*
> *But if there is no IPRs protection, our firm will only develop very important technology for our own production. The enthusiasm for doing R&D will decrease, because we cannot expect as much benefit as we can get now.*

A technological executive of the 12th interview with a big petroleum firm said:

> *I think there will be a negative impact on technology development in our firm if there is no IPRs protection, because we cannot have great benefits from new technology. But our firm is a state-owned firm, so the government has support and guide for us. If there is no IPRs protection, we still need to do R&D just like what happened before China implemented its new IPRs protection. Whether there is IPRs protection or not, we cannot get important technology from foreign countries.*

A technological executive of the 11th interview with a small electronic firm said:

> *If the technology of our firm is imitated by other competitors, our firm will suffer great losses. Our firm is a small-sized firm in our sector. The cost of building a production line like our firm is not very high in the electronic sector. It is easy to set up another firm like us in a short*

period of time. So, if our technology is imitated by others, the competitive advantage will be reduced greatly and the other firms will sell similar products at lower prices to occupy the market because the imitation costs is much lower than doing the R&D. So, if there is no IPRs protection, our firm will do not want to develop technology by ourselves. Our firm will also try to imitate technology from other firms. This can reduce the cost.

A technological executive of the 16th interview with a big machinery firm said:

Although imitation can bring some losses of benefit for our firm, the negative impact is not very big. Our firm is one of the biggest firms in our sector in our country. Only one production line in our firm needs a great amount of money. Other firms cannot get it. Even if other firms imitate our technology, without the production line they cannot produce products. We have our own technicians and systems of raw material supply, which is difficult to set up by other firms. Certainly, we do not want to see the imitation of our technology and we control our technology very strictly. But if there is imitation, other firms cannot achieve commercial production of the technology. But, imitation indeed reduces the profit of our firm.

Without IPRs protection, we still want to do R&D, because new technology means more competitive ability for our firm. But if anyone else can imitate our technology freely, we will do not do research on long-term technology, because the input is large and it takes long time to get a profit from it. Foreign firms will also worry about their technology if there is no IPRs protection. But earning money is very important for them and China has a great market, so foreign firms will want to do business and have their technology used by firms in our country because they can earn money here.

A technological executive of the 30th interview with a small traditional food firm said:

Our secrets are obtained from a long period of production experience. This is quite important for our firm. We protect and control it in strict secrecy. If this secret becomes known to other firms, there will be very great losses for our firm. I heard about this case in another traditional food firm. That firm cannot survive any more. Firms in our sector are almost small-sized firms. Firms in this sector mainly depend on different secrets. No secrets equals no competitive ability.

A government official of the 14th interview said:

If the publication is pirated by others, there will be money lost for the

authors and the publishing firms. But sometimes, the authors will lose more than publishing firms. Now, some publishing firms ask the authors to buy all the leftover publications in order to make sure that the publishing firms will not lose if publications cannot be sold out. This requirement sometimes is listed in the publishing contract. But, there are still some authors, who do not want to earn money but want to become famous. So, these authors sometimes use their own money to publish their works. These authors do not care whether their publications are pirated or not. Some of them think that the pirating of their publications can also help them to become famous. But in general, if there is no IPRs protection, the number of publications by residents and foreigners will be reduced. This is easy to explain. In the past, when China did not have IPRs protection, the number of publications by Chinese residents and by foreigners was much less than that in the present period when IPRs protection has improved.

A technological executive of the 17th interview with a medium software firm said:

Pirating in software in our country is still serious. So, our firm tries our best to protect our software through using IPRs protection and some coding technology. If our software is pirated by others, we will suffer great losses. The production or reproduction of software is very cheap, so if our software is copied by others, sometimes, we cannot earn any profit. No one wants to buy original software, if the function of pirated software is the same that of the original. So, there will be great negative impact on developing software if there is no IPRs protection. Foreign software firms will not want to sell their software in our country. Foreign software firms still complain about the bad enforcement of IPRs protection on software in our country even though the enforcement has been improved. So, without IPRs protection, foreign firms will control their software more strictly in our country.

According to technological executives in the pharmaceutical and the chemical sectors, even if imitation occurred, firms could still get financial returns to cover their costs in R&D since their products could enter the market earlier than competitors with the existing production capability, but their profit would be reduced. Moreover, executives in the pharmaceutical and chemical sectors also believed that even if there was no IPRs protection, their firms would still do R&D, although the number of technologies developed by their firms would be reduced. According to some pharmaceutical and chemical executives, without IPRs, the amount of technology developed by Chinese

firms and transferred from foreign countries in these sectors would be reduced.

Although there was some negative impact on the development of technology by Chinese petroleum firms without IPRs protection, with the support of the Chinese government, these firms would still do R&D. Technology transfer in this sector were not affected much by the change of IPRs policy.

Technological executives of most big firms in the electronic, machinery, primary metals and transportation equipment sectors considered that their firms could still make profit by new technologies even if imitation occurs, because it was difficult for other firms to compete with their productivity in a short time and their new products could enter the market sooner than those of others. These firms had their own comparatively large workshops, advanced or improved equipment that could only be afforded by rich firms, skilled workers who could operate this equipment, and the administrative system of purchasing and sales. These were quite difficult to copy for small firms or other big electronic firms in a short period of time. Thus, even if the technology of these firms got copied by competitors, they could not do commercial production using this kind of technology in a short time without having the same production capability. Technological executives of these big firms said that their firms could sell technological products at high prices during the short period of time to make profit, which could cover the cost of R&D. Executives of small firms in these sectors believed that if there was imitation of their technology, their firms could not get financial return to cover the costs of R&D, because their production capability could be easily matched by other firms. Most small firms did not have special workshops or administrative systems for purchasing and sales. The equipment of most small firms in these sectors could be easily set up by their competitors. The flow of skilled workers among small firms was relatively frequent. Thus, it was easy to get similar production capabilities for these firms. Technological executives of these firms said that if their technology was copied by other firms, it would be easy for the competitors to produce similar product in a short period of time and to sell at lower prices to gain more market share, because the cost of obtaining these

technologies was much less than developing them. Therefore, firms could not get enough financial return to cover their cost of R&D. Without IPRs protection, although there was some negative impacts on the enthusiasm of doing R&D, big firms and state-owned firms in electronic, machinery, primary metals and transportation equipment sectors would still invest in R&D, because there was limited impact on their benefit from developing technology. However, small firms and most private firms in the same sectors would not want to do R&D or to get new technology through other reasonable and legal methods, instead, they would prefer to get technology through imitation to keep the costs low. According to some executives, although there was a negative influence on technology transfer from foreign countries without IPRs protection, some foreign firms would still want to transfer their technology to Chinese firms in these sectors, because China's big market had great attraction for foreign firms.

For the traditional food sector, if traditional secrets were imitated by other firms, benefit would be reduced greatly. As some executives said, the reasons for this were that firms in the traditional food sector were relatively small and their production lines were easy to copy. Therefore, if a firm's technology and secrets were imitated by others, this firm's benefit would decrease dramatically and might even lead to the bankruptcy of the firm. However, for most firms in this sector that had no special technology and secrets, imitation had no impact on their production.

For the publishing sector, interviewees said that according to their investigation, when pirated publications appeared in the market, sometimes publishing companies could not get a financial return to cover their costs on producing the original publications. The interviewees said that the monetary benefit of authors would reduce dramatically and their losses would be bigger than the publishing firms, if pirated copies of their publications were available in the market. Without IPRs protection, many publishing companies did not want to produce original publications, as it was not profitable, but some authors still wanted to publish their works, because they cared more about their reputation than the monetary gain. Interviewees also believed that if there was no IPRs

protection available, the numbers of publications transferred from foreign countries would fall greatly, because foreign publishing companies were afraid of piracy of their intellectual works.

For the software sector, if there was imitation of their technology, the executives considered that their benefit obtaining from new technologies would reduce dramatically. The reasons for this were that the cost of imitation in this sector was quite low and productivity was easy to obtain. Thus, without IPRs protection, the number of technologies developed by Chinese firms and transferred from foreign countries would be reduced, according to the technological executives in the software sector.

Impact of other policies on technology diffusion

A technological executive of the 1st interview with a big chemical firm said:

> *Before China implemented the "Open Door" policy, it was impossible for Chinese firms to have contact with foreign firms. At that time, Chinese firms did not have the right of direct imports and exports. If a Chinese firm wanted to import some technological products from foreign countries, it had to obtain permission from the Chinese government first. The procedure for obtaining the permission was very complicated and time consuming. Sometimes, when the permission was obtained, the technological product needed by a Chinese firm had been replaced by a new product. Nowadays, it is easy for Chinese firms to have contact with foreign countries. It is easy to get the right of direct imports and exports for Chinese firms. Chinese firms have the right to decide which technological product is useful for their firms and import directly. It used to be very difficult or even impossible for a Chinese firm to get a licensing contract with a foreign firm without the permission of the Chinese government; this is no long the case. Moreover, Chinese firms can also cooperate with foreign firms in R&D, which was impossible before China implemented the "Open Door" policy.*

A technological executive of the 28th interview with a big electronic firm said:

> *The "Open Door" policy is very important for technology development and diffusion in China. Before this policy, the Chinese government would not learn contemporary IPRs protection policy from developed countries. Without this policy, the Chinese government would not know the*

importance of new technologies. Even if there was IPRs protection policy in China, without the implementation of the "Open Door" policy, technologies could not enjoy the current development or diffusion, because China did not have much technology. Without learning basic technology from foreign countries, firms could not obtain the current development or diffusion.

A technological executive of the 32nd interview with a small machinery firm said:

Now different municipal governments have their own methods to promote technological development. In our city, if a firm gets one patent, the municipal government will reward 300 thousand Chinese Yuan to the firm. This policy encourages firms to do research and development.

A technological executive of the 10th interview with a big transportation equipment firm said:

Sometimes, some foreign firms did not care much about IPRs protection in China. They paid more attention on China's foreign investment policy, because it provides many favourable terms for foreign firms to invest in China, such as tax reduction and the supply of land for plant. These favourable terms sometimes attracted foreign firms to invest with money and technologies in China without considering its IPRs protection policy.

A technological executive of the 16th interview with a big machinery firm said:

Managers of some foreign firms know that Chinese IPRs protection is not as good as that in some foreign countries. Managers of these firms also know that there are still some imitation risks in China. However, they still want to sell their technological products to China and still want to use their technologies to invest in China. China has a great market in the world, and even though technologies of these foreign firms were imitated by some Chinese firms, the big market can still bring great benefit for these foreign firms.

A technological executive of the 22nd interview with a big machinery firm said:

The software sector is a kind of new and high-tech industrial sector in China. The government takes measures to promote the development of this sector, such as providing materials and money to software firms. These supportive policies are very helpful for the development of software technologies.

Many interviewees said that the "Open Door" policy implemented in China was very helpful for technology diffusion, especially technology transfer from foreign countries to China. The implementing of the "Open Door" policy in China allowed Chinese firms to have contact with foreign firms. This improved communication on technology and technological products, which provided opportunities for Chinese firms to obtain technology from foreign countries. Thus, the "Open Door" policy promoted technology diffusion in China. Some interviewees also said that policies on encouraging economic development also helped technology development and diffusion in China. They said that these policies encouraged Chinese firms to pay more attention to their production and management. This led to the development of technology, which could bring more new technological products and more profits. These interviewees also said that the economic development in China also provided money and resources for the Chinese government to invest in technology development. Some interviewees considered that the Chinese government's policy on encouraging R&D also promoted the development and diffusion of technology. Some believe that China's foreign investment policy also encouraged technology transfer from foreign countries to China. Some favourable terms in China's foreign investment policy promoted foreign investment using money and technology in China, which encouraged technology transfer from foreign countries to China. China's big market also encouraged technology diffusion, especially technology transfer from foreign countries to China. Moreover, some industrial policies also promoted technology development and diffusion in China.

Opinions on IPRs protection reform

Almost all interviewees believed that China's implementing stronger IPRs protection was very needed and good for technology development and technology diffusion. Just as a technological executive of the 2nd interview with a big pharmaceutical firm said:

> *It is necessary to reinforce IPRs protection in China. The current IPRs protection policy is vital to promote technology development and diffusion. Chinese IPRs protection has improved recently. However, IPRs protection in China is not as strong as that in developed countries. It is*

necessary to reinforce Chinese IPRs protection policy further in the future. I have not found any disadvantage on IPRs protection policy. The current IPRs protection is an advanced policy. We need to learn about and use it.

However, when talking about specific impacts of IPRs policy on technology development and diffusion, most of interviewees could give some negative impacts of current IPRs protection policy on technology development and diffusion. Most of the interviewees even did not realize that they mentioned some negative impact of the current IPRs protection according to their experience. They just believed that the current IPRs protection was very good for technology development and diffusion in China and the government needs to reinforce IPRs policy in the future. One reason for this may be that there were no other feasible policies available for protecting technology, hence people believed that the current IPRs protection was the best policy to protect technology and promote technology development and diffusion. Another reason may be that government propaganda and conventional ideas stated that the current IPRs policy was the best method to protect technology and encourage technology diffusion. The government's viewpoint and conventional opinion had a great influence on people's opinions.

Table 3: The results of analysing semi-structured interviews

TD: technology diffusion; DT: domestic technology; TT: technology transfer; Ph: pharmaceutical; C: chemical; Pe: petroleum; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; Pu: publishing; S: software

	Ph	C	Pe	E	M	Pm	Tr	Tf	T	Pu	S
Feel of IPRs reform	Feel it							Do not feel it		Feel it	
Sensitivity to IPRs	High				Moderate			Low		High	

Table 3: The results of analysing semi-structured interviews (continued)

	Ph	C	PE	E	M	Pm	Tr	Tf	T	Pu	S
Positive impact of IPRs reform	DT increased, TT increased less than DT		DT increased, TT did not increase	DT increased, TT increased less than DT				No increase on DT and TT		DT and TT increased	DT increased, TT increased less than DT
Negative impact of IPRs reform	Took other measures to protect technology, delay of technology's commercial production, difficult to get patented technology.										
Impact of imitation on TD	If imitation occurred, firms could still get benefit from technology. The number of technology would reduce. Firms would still do R&D.		If imitation occurred, with the guide of Chinese government, firms would still do R&D.	If imitation occurred, big firms could get benefit, small firms could not get benefit. Big and state-owned firms would do R&D; small and private firms would not do R&D. There would still some TT, because of big market.				If imitation occurred, benefit would reduce greatly.		Benefit for firms and authors would reduce, some authors would still want to publish works, TT would reduce.	Benefit would reduce greatly, TD and TT would reduce.
Impact of other policies on TD	Open Door policy, policies on encouraging economic development, policy on encouraging R&D, China's foreign investment policy, China's big market, and some industry policies promoted TD in China.										
Opinions on IPRs reform	All believed that China's implementing stronger IPRs policy was very good for TD, although they expressed some negative impacts of the current IPRs policy.										

Table 3 summaries the main points of interview data in different industries. It shows that interview data presented both similarities and differences related to stronger IPRs protection and technology diffusion in China among different industries.

Chart 1: The diagram of analyzing semi-structured interviews

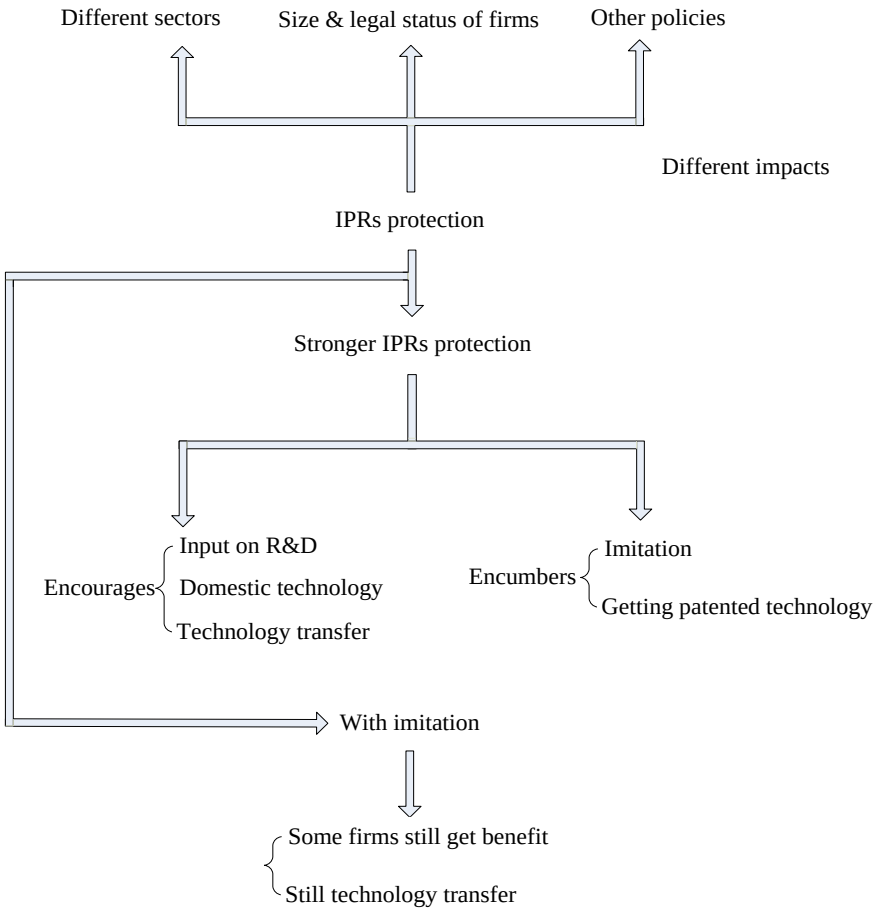


Chart 1 demonstrates the general relation between IPRs protection reform and technology diffusion in China obtained from interview data. It can be seen from this chart that China reformed its IPRs protection policy since the country tried to join the WTO. The relation between IPRs protection and technology diffusion had connections with different industrial sectors, different sizes and legal statuses of Chinese firms, and other policies in China. Stronger IPRs protection had both positive and negative impacts on technology diffusion in China. Without IPRs protection, some firms could still get benefits to cover their costs in doing R&D even if imitation occurred. Firms with productive capabilities that were difficult to copy in a short time could still get benefit from their technologies. Without good IPRs protection, there would still be some technologies developed by Chinese firms and transferred from foreign countries to China.

6.3. Analysing self-completion questionnaire

This part analyses the data obtained through the self-completion questionnaires. The process of analysing questionnaire is explained. The analytical result of the self-completion questionnaire data is also shown.

6.3.1. The process of analysing self-completion questionnaire

The date collected from questionnaires was analysed through the following procedures. Firstly, each answered questionnaire was divided into different categories according to different industries, firm sizes, and legal status of these firms (state-owned or private). This classification helped to illustrate whether technological executives in firms of different industries, sizes and legal status provided different responses to questions about the relation between IPRs protection and technology diffusion in China. Secondly, answered questionnaires in each selected industry were analysed. These analyses helped to find out the main points of each selected industry. Finally, the analytical results for different selected industries were compared. This comparison provided the similarities and differences among different selected industries, which helped to summarise the main points of analytical results for all selected industries.

6.3.2. Analytical results for self-completion questionnaire

Through analysing and comparing the self-completion questionnaires in different selected industries, some main points were generalised: (a) legal status and size of firms; (b) number of patented technologies; (c) feel of stronger IPRs protection; (d) methods of acquiring technology; (e) impact of stronger IPRs on technology diffusion in China; (f) impact of stronger IPRs on firm's technology development; (g) impact of stronger IPRs on technology transfer in individual firms; (h) impact on technology diffusion without IPRs protection; (i) opinion on the current IPRs policy. This part only presents the results of questionnaires. It does not analyse the results. The next chapter focuses on the analyses of fieldwork results.

Legal status and size of firms

According to the market share of firm's leading products in China and the number of full-time staff in total, firms were divided into different categories according to the firm size. Pharmaceutical, chemical, machinery and software firms were divided into big, medium and small firms. Electronic, primary metal and transportation equipment firms were divided into big and small firms. For pharmaceutical, chemical, machinery and software sectors, big firms were state-owned; small firms were private; and medium firms included both state-owned and private. For electronic and primary metal sectors, most big firms were state-owned and most small firms were private. For the transportation equipment sector, all big firms were state-owned and small firms included both state-owned and private firms. The traditional food and the textile sectors were all small firms, which included both state-owned firms and private firms.

Number of patented technologies

Table 4 Average number of patented technologies held by Chinese firms

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software

Industries	Big firms	Medium firms	Small firms	Average
Ph	41.5	10.5	9	20.33
C	21.25	9.25	2.25	10.92
E	1332.83		27.17	680
M	12	2	0	4.67
Pm	21		1.67	11.34
Tr	38.83		4.67	21.75
Tf			0.5	0.5
T			0	0
S	9.75	4	1.25	5

Source: obtained from questions T9-T10, which are shown in Appendix 6.

Table 4 shows that pharmaceutical, chemical, electronic, primary metal and transportation equipment firms held comparatively more patented technologies. Each

selected pharmaceutical chemical, electronic, primary metal and transportation equipment firm had 20.33, 10.92, 680, 11.34 and 21.75 patented technologies on average separately. Machinery firms held comparatively fewer patented technologies, which were 4.67 on average. Traditional food and textile firms held very limited patented technologies, which were 0 and 0.5 on average separately. Each selected software firm held 5 technologies protected by copyright on average. Overall, big firms held more technology protected by IPRs than small firms.

Feel of stronger IPRs protection

Table 5 Opinion on whether China's entrance to WTO has led to stronger adopting of IPRs protection

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software

Industries	Big firms	Medium firms	Small firms
Ph	All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.		
C	All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.		
E	All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.		All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.
M	All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.		50% believe that China's entrance to WTO has led to stronger adopting of IPRs protection, and 50% do not know.
Pm	All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.		67% believe that China's entrance to WTO has led to stronger adopting of IPRs protection, and 33% do not know.
Tr	All believe that China's entrance to WTO has led to stronger adopting of IPRs protection.		67% believe that China's entrance to WTO has led to stronger adopting of IPRs protection, and 33% do not know.
Tf			33% believe that China's entrance to WTO has led to stronger adopting of IPRs protection, and 67% do not know.
T			58% believe that China's entrance to WTO has led to stronger adopting of IPRs protection, and 42% do not know.
S	All believed that China's entrance to WTO had led to stronger adopting of IPRs protection.		

Source: obtained from question T12, which is shown in Appendix 6.

From table 5, it can be seen that all the selected technological executives of firms in the pharmaceutical, chemical, electronic and software sectors felt that China had implemented stronger IPRs protection. The technological executives of all selected big firms and some selected small firms in machinery, primary metal and transportation equipment sectors felt that China had implemented stronger IPRs protection. Only some technological executives in the traditional food and textile sectors felt that China had implemented stronger IPRs protection, since China tried to accede to the WTO.

Methods of acquiring technology

Table 6 Methods to acquire technology before China reformed IPRs protection

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software; DT: domestic trade; IT: international trade; DL: domestic licensing; IL: international licensing; DI: domestic imitation; II: international imitation

Industries	Big firms	Medium firms	Small firms
Ph	All through R&D, II, sharing technology with other state-owned firms, 25% through IL.	All through II, 50% through R&D, 50% through DI, 25% through DL, state-owned medium firms through sharing technology with other state-owned firms.	All through DI and II.
C	25% through R&D, 75% through IT, 25% through DL, 75% through IL, and all through II.	50% through R&D and DI, 25% through IT and DL, and 50% through II.	50% through DT, 25% through DL, all through DI, and 50% through II.
E	67% through R&D, 83% through IT, 83% through IL, 33% through DI, and all through II.		All through DT, 67% through IT, 17% through DL, 17% through IL, 67% through DI, 83% through II.
M	50% through DT, all through IT, 50% through DL, 50% through DI, and all through II.	All through DT, 50% through IT, 25% through DL, 75% through DI, and 50% through II.	All through DI.
Pm	83% through R&D, 33% through DT, 67% through IT, 17% through Dl and IL, 33% through DI, and 67% through II.		All through DT and DI, 67% thought IT, and 50% through II.

Table 6 Methods to acquire technology before China reformed IPRs protection

(continued)

Industries	Big firms	Medium firms	Small firms
Tr	50% through R&D, all through IT, 33% through IL, all through II, and 33% through sharing technology with other state-owned firms.		83% through DT, 67% through IT, 83% through DI and II.
Tf			All through traditional techniques.
T			All through traditional techniques.
S	All through R&D, 25% through DI, 75% through II.	75% through DT and IT, 50% through DI, and 75% through II.	All through DI and II.

Source: obtained from question T11, which is shown in Appendix 6.

From table 6, it is known that before China adopted stronger IPRs protection, most big and medium pharmaceutical firms acquired technologies through R&D and sharing technologies with other state-owned firms. Before China adopted stronger IPRs protection, most selected pharmaceutical, chemical, electronic, primary metals, machinery, transportation equipment and software firms acquired technologies through imitation. All selected traditional food and textile firms acquired technologies through traditional techniques, before China adopted stronger IPRs protection.

Table 7 Whether firms' main methods to acquire technology changed after China adopted stronger IPRs protection

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software;

Industries	Big firms	Medium firms	Small firms
Ph	All changed their main methods of acquiring new technology.		
C	All changed their main methods of acquiring new technology.		50% changed, 50% did not change.

Table 7 Whether firm's main methods to acquire technology changed after China adopted stronger IPRs protection (continued)

Industries	Big firms	Medium firms	Small firms
E	All changed their main methods of acquiring new technology.		67% changed, 33% did not change.
M	All changed their main methods of acquiring new technology.		All did not change.
Pm	All changed their main methods of acquiring new technology.		50% changed, 50% did not change.
Tt	All changed their main methods of acquiring new technology.		67% changed, 33% did not change.
Tf			All did not change their main methods of acquiring new technology.
T			All did not change their main methods of acquiring new technology.
S	All changed their main methods of acquiring new technology.		

Source: obtained from question T13, which is shown in Appendix 6.

Table 7 shows that after China adopted stronger IPRs protection, all selected pharmaceutical and software firms changed their main methods of acquiring technologies. All the selected big and medium firms and some selected small firms in the chemical, electronic, primary metal and transportation equipment sectors changed their main methods of acquiring technologies. All the selected big and medium firms in the machinery sector changed their main methods of acquiring technologies. But none of the small firms in machinery sector changed their main methods of acquiring technologies. After China adopted stronger IPRs protection, none of the selected traditional food and textile firms changed their main methods of acquiring technologies.

Table 8 Methods to acquire technology after China enforced stronger IPRs protection

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; S: software; DT: domestic trade; IT: international trade; DL: domestic licensing; IL: international licensing; DI: domestic imitation; II: international imitation

Industries	Big firms	Medium firms	Small firms
Ph	All through R&D, IT, FDI, DL and IL, 75% through R&D cooperating with research institutes, 25% through waiting for foreign overdue technology.	All through DL, IL, R&D cooperating with research institutes, and waiting for foreign overdue technology, 75% through R&D, 25% through IT, and FDI.	All through DI and R&D cooperating with research institutes, 75% through II, 50% through waiting for foreign overdue technology, and 25% through IL.
C	All through R&D, IL and R&D cooperating with research institutes, 25% through DT, 50% through IT, and 75% through DL.	All through R&D and R&D cooperating with research institutes, 25% through DT, 50% through IT, 25% through FDI, 75% through DL, and 50% through IL.	50% changed their methods of getting technology, in them all through R&D, DT, and IT, and 50% through DL.
E	All through R&D, 50% through DT, 67% through IT, 33% through FDI, 33% through DL, 67% through IL, 50% through R&D cooperating with research institutes.		67% changed their methods of getting technology, in them all through R&D, DT, 75% through IT, 50% through DL, 75% through IL.
M	All through R&D, 50% through IT, 50% through DL, 25% through IL, and 25% through R&D cooperating with research institutes.	All through R&D, 75% through DT, all through IT and DL, and 25% through DI.	All did not change their methods of getting new technology.
Pm	All through R&D, 17% through DT, 50% through IT, 17% FDI, 50% through DL, 83% through IL, and all through R&D cooperating with research institutes.		50% changed their methods of getting technology, in them all through R&D, DT, and IT, 33% through II and 67% through R&D cooperating with research institutes.

Table 8 Methods to acquire technology after China enforced stronger IPRs protection (continued)

Industries	Big firms	Medium firms	Small firms
Tr	All through R&D, 17% through DT, 50% through IT, 83% FDI, 17% through DL, all through IL, and 67% through R&D cooperating with research institutes.		67% changed their methods of getting technology, in them all through R&D, 75% through DT, 50% through IT, 25% through DL, 50% through IL, and 50% through R&D cooperating with research institutes.
S	All through R&D, and 50% through IL.	All through R&D, 75% through DT, 50% through IT, and 25% through IL.	All through R&D, and 50% through DI and II.

Source: obtained from question T14, which is shown in Appendix 6.

From table 8, it can be seen that after China adopted stronger IPRs protection, big and medium firms in the pharmaceutical, chemical, electronic, primary metals, transportation equipment and software sectors stopped imitation, and instead used legitimate methods to acquire technologies. Although some small firms in these sectors still imitated, they also started to do R&D by themselves or cooperating with research institutes. After China adopted stronger IPRs protection, all big machinery firms stopped imitation. Some medium and small machinery firms continued with imitation.

It should be mentioned that firms with the right of direct imports and exports could acquire technology through international trade, FDI, international licensing. Firms without the same right could not acquire technology through the same channel.

Impact of stronger IPRs on technology diffusion in China

Table 9 Opinions about impact of stronger IPRs on technology diffusion in China

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software; SIP: stronger IPRs protection; DDT: the development of domestic technology; TT: technology transfer

Industries	Big firms	Medium firms	Small firms
Ph	All believe that SIP strongly encourages DDT and TT.	All believe that SIP strongly encourages DDT, 25% believe that SIP strongly encourages TT, 75% believe that SIP slightly encourages TT.	All believe that SIP strongly encourages DDT, 50% believe that SIP slightly encourages TT, 50% consider that SIP has no impact on TT.
C	All believe that SIP strongly encourages DDT; all believe that SIP has no impact on TT.	All believe that SIP strongly encourages DDT, 50% believe that SIP strongly encourages TT, and 50% believe that SIP slightly encourages TT.	50% believe that SIP strongly encourages DDT, 25% believe that SIP slightly encourages DDT, 25% believe that SIP has no impact on DDT, 25% believe that SIP strongly encourages TT, and 75% believe that SIP slightly encourages TT.
E	All believe that SIP strongly encourages DDT; 67% believe that SIP strongly encourages TT, 33% believe that SIP slightly encourages TT.		All believe that SIP strongly encourages DDT; 50% believe that SIP strongly encourages TT, 50% believe that SIP slightly encourages TT.
M	All believe that SIP strongly encourages DDT, 75% believe that SIP strongly encourages TT, 25% believe that SIP slightly encourages TT.	All believe that SIP strongly encourages DDT, 25% believe that SIP strongly encourages TT, 75% believe that SIP slightly encourages TT.	75% believe that SIP strongly encourages DDT, 25% believe that SIP slightly encourages DDT, 25% believe that SIP slightly encourages TT, 75% do not know the impact of SIP on TT.
Pm	67% believe that SIP strongly encourages DDT and TT, and 33% believe that SIP slightly encourages DDT and TT.		50% believe that SIP strongly encourages DDT, 50% believe that SIP slightly encourages DDT, 17% believe that SIP strongly encourages TT, 50% believe that SIP slightly encourages TT, 33% believe that SIP has no impact on TT.

Table 9 Opinions about impact of stronger IPRs on technology diffusion in China

(continued)

Industries	Big firms	Medium firms	Small firms
Tr	All believe that SIP strongly encourages DDT and TT.		67% believe that SIP strongly encourages DDT, 17% believe that SIP slightly encourages DDT, 17% believe that SIP has no impact on DDT, 33% believe that SIP strongly encourages TT, 33% believe that SIP slightly encourages TT, 33% believe that SIP has no impact on TT.
Tf			25% believe that SIP strongly encourages DDT, 42% believe that SIP slightly encourages DDT, 33% do not know the impact of SIP on DDT, all do not know the impact of SIP on TT.
T			33% believe that SIP strongly encourages DDT, 8% believe that SIP slightly encourages DDT, 58% do not know the impact of SIP on DDT, 25% believe that SIP strongly encourages TT, 75% do not know the impact of SIP on TT.
S	All believe that SIP strongly encourages DDT, 75% believe that SIP strongly encourages TT, and 25% believe that SIP slightly encourages TT.	All believe that SIP strongly encourages DDT, 50% believe that SIP strongly encourages TT, and 50% believe that SIP slightly encourages TT.	All believe that SIP strongly encourages DDT, 75% believe that SIP slightly encourages TT, 25% believe that SIP has no impact on TT.

Source: obtained from questions T15-T16, which are shown in Appendix 6.

Table 9 demonstrates that most technological executives in pharmaceutical, chemical, electronic, primary metals, machinery, transportation equipment and software sectors believed that stronger IPRs protection had encouraged the development of domestic technology and technology transfer from foreign countries in China. Technological executives of most textile firms did not know the impact of stronger IPRs protection on domestic technology development or technology transfer in China. Technological executives of most traditional food firms considered that stronger IPRs protection had

encouraged domestic technology development in China. However, none of them knew the impact of stronger IPRs protection on technology transfer in China.

Impact of stronger IPRs on firm's technology development

Table 10 Opinions about impact of stronger IPRs on firm's technology development and technology's commercial production

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software; SIP: stronger IPRs protection; DFT: the development of firm's technology; CFT: the commercial production of firm's technology

Industries	Big firms	Medium firms	Small firms
Ph	All believe that SIP strongly encourages DFT, 50% believe that SIP strongly encourages CFT, 50% believe that SIP slightly encourages CFT.	All believe that SIP strongly encourages DFT, 50% believe that SIP slightly encourages CFT, 50% believe that SIP has no impact on CFT.	25% believe that SIP strongly encourages DFT, 75% believe that SIP slightly encourages CFT, 25% believe that SIP slightly encourages CFT, 75% believe that SIP has no impact on CFT.
C	50% believe that SIP strongly encourages DFT, 50% believe that SIP slightly encourages DFT, 50% believe that SIP strongly encourages CFT, 25% believe that SIP slightly encourages CFT, and 25% believe that SIP has no impact on CFT.	All believe that SIP strongly encourages DFT, 50% believe that SIP slightly encourages CFT, 50% believe that SIP has no impact on CFT.	50% believe that SIP strongly encourages DFT, 50% believe that SIP slightly encourages DFT, and all believe that SIP has no impact on CFT.
E	All believe that SIP strongly encourages DFT, 33% believe that SIP strongly encourages CFT, 33% believe that SIP slightly encourages CFT, 33% believe that SIP has no impact on CFT.		All believe that SIP strongly encourages DFT, 50% believe that SIP slightly encourages CFT, 50% believe that SIP has no impact on CFT.

Table 10 Opinions about impact of stronger IPRs on firm's technology development and technology's commercial production (continued)

Industries	Big firms	Medium firms	Small firms
M	All believe that SIP strongly encourages DFT, 50% believe that SIP slightly encourages CFT, 50% believe that SIP has no impact on CFT.	75% believe that SIP strongly encourages DFT, 25% believe that SIP slightly encourages DFT, all believe that SIP has no impact on CFT.	25% believe that SIP slightly encourages DFT, 75% believe that SIP has no impact on DFT, 50% believe that SIP has no impact on CFT, 50% do not know.
Pm	All believe that SIP strongly encourages DFT, 50% believe that SIP strongly encourages CFT, 17% believe that SIP slightly encourages CFT, 33% believe that SIP has no impact on CFT.		50% believe that SIP strongly encourages DFT, 17% believe that SIP slightly encourages DFT, 33% believe that SIP has no impact on DFT, 17% believe that SIP strongly encourages CFT, 50% believe that SIP slightly encourages CFT, 33% believe that SIP has no impact on CFT.
Tr	All believe that SIP strongly encourages DFT, 33% believe that SIP slightly encourages CFT, 67% believe that SIP has no impact on CFT.		50% believe that SIP strongly encourages DFT, 17% believe that SIP slightly encourages DFT, 33% believe that SIP has no impact on DFT, 50% believe that SIP slightly encourages CFT, 50% believe that SIP has no impact on CFT.
Tf			All believe that SIP has no impact on DFT and CFT.
T			75% believe that SIP has no impact on DFT, 25% do not know the impact of SIP on DFT, all believe that SIP has no impact on CFT.

Table 10 Opinions about impact of stronger IPRs on firm's technology development and technology's commercial production (continued)

Industries	Big firms	Medium firms	Small firms
S	All believe that SIP strongly encourages DFT, 75% believe that SIP strongly encourages CFT, 25% believe that SIP slightly encourages CFT.	All believe that SIP strongly encourages DFT, 25% believe that SIP strongly encourages CFT, 75% believe that SIP slightly encourages CFT.	All believe that SIP strongly encourages DFT, 25% believe that SIP strongly encourages CFT, 25% believe that SIP slightly encourages CFT, 50% believe that SIP has no impact on CFT.

Source: obtained from questions T17-T18, which are shown in Appendix 6.

Table 10 shows that most technological executives in the selected pharmaceutical, chemical, electronic and software firms considered that stronger IPRs protection had strongly encouraged their firm's technology development. Most technological executives of the selected pharmaceutical and software firms believed that stronger IPRs protection had encouraged technology's commercial production in their firms. Most technological executives of chemical and electronic firms believed that stronger IPRs protection had no impact on technology's commercial production in their firms.

Most technological executives in machinery and primary metal firms and half technological executives in transportation equipment firms believed that stronger IPRs protection had encouraged their firm's technology development. Technological executives of most machinery and transportation equipment firms believed that stronger IPRs protection had no impact on technology's commercial production in their firms. Technological executives of most primary metal firms believed that stronger IPRs protection had encouraged technology's commercial production in their firms.

Technological executives in most selected traditional food and textile firms believed that stronger IPRs protection had no impact on technology development or technology's commercial production in their firms.

Impact of stronger IPRs on technology transfer in individual firms

Table 11 Opinions about impact of stronger IPRs protection on technology transfer through different channels

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software; SIP: stronger IPRs protection; TT: technology transfer; IT: international trade; L: Licensing; I: imitation

Industries	Channels	Big firms	Medium firms	Small firms
Ph	IT	All believe that SIP strongly encourages TT through IT.	50% believe that SIP strongly encourages TT through IT, 50% believe that SIP has no impact on TT through IT.	75% believe that SIP has no impact on TT through IT, 25% believe that SIP slightly encourages TT through IT.
	FDI	All believe that SIP strongly encourages TT through FDI.	50% believe that SIP strongly encourages TT through FDI, 50% believe that SIP has no impact on TT through FDI.	All believe that SIP has no impact on TT through FDI.
	L	All believe that SIP strongly encourages TT through L.	All believe that SIP strongly encourages TT through L.	75% believe that SIP slightly encourages TT through L, 25% believe that SIP has no impact on TT through L.
	I	All believe that SIP strongly encumbers TT through I.		
C	IT	25% believe that SIP strongly encourages TT through IT, 75% believe that SIP slightly encourages TT through IT.	50% believe that SIP strongly encourages TT through IT, 25% believe that SIP slightly encourages TT through IT, 25% believe that SIP has no impact on TT through IT.	50% believe that SIP slightly encourages TT through IT, 50% believe that SIP has no impact on TT through IT.
	FDI	25% believe that SIP slightly encourages TT through FDI, 75% believe that SIP has no impact on TT through FDI.	50% believe that SIP slightly encourages TT through FDI, 50% believe that SIP has no impact on TT through FDI.	All believe that SIP has no impact on TT through FDI.

Table 11 Opinions about impact of stronger IPRs protection on technology transfer through different channels (continued)

Industries	Channels	Big firms	Medium firms	Small firms
C	L	50% believe that SIP strongly encourages TT through L, 50% believe that SIP slightly encourages TT through L.	25% believe that strongly encourages TT through L, 25% believe that slightly encourages TT through L, 50% believe that SIP has no impact on TT through L.	25% believe that slightly encourages TT through L, 75% believe that SIP has no impact on TT through L.
	I	All believe that SIP strongly encumbers TT through I.		
E	IT	83% believe that SIP strongly encourages TT through IT, 17% believe that SIP slightly encourages TT through IT.		33% believe that SIP strongly encourages TT through IT, 33% believe that SIP slightly encourages TT through IT, 33% believe that SIP has no impact on TT through IT.
	FDI	33% believe that SIP strongly encourages TT through FDI, 33% believe that SIP slightly encourages TT through FDI, 33% believe that SIP has no impact on TT through FDI.		67% believe that SIP slightly encourages TT through FDI, 33% believe that SIP has no impact on TT through FDI.
	L	All believe that SIP strongly encourages TT through L.		50% believe that SIP strongly encourages TT through L, 17% believe that SIP slightly encourages TT through L, 33% believe that SIP has no impact on TT through L.
	I	All believe that SIP strongly encumbers TT through I.		33% believe that SIP slightly encumbers TT through I, 67% believe that SIP strongly encumbers TT through I.

Table 11 Opinions about impact of stronger IPRs protection on technology transfer through different channels (continued)

Industries	Channels	Big firms	Medium firms	Small firms
M	IT	75% believe that SIP strongly encourages TT through IT, 25% believe that SIP slightly encourages TT through IT.	50% believe that SIP slightly encourages TT through IT, 50% believe that SIP has no impact on TT through IT.	All believe that SIP has no impact on TT through IT.
	FDI	25% believe that SIP strongly encourages TT through FDI, 25% believe that SIP slightly encourages TT through FDI, 50% believe that SIP has no impact on TT through FDI.	25% believe that SIP slightly encourages TT through FDI, 75% believe that SIP has no impact on TT through FDI.	75% believe that SIP has no impact on TT through FDI, 25% do not know.
	L	75% believe that SIP strongly encourages TT through L, 25% believe that SIP slightly encourages TT through L.	75% believe that SIP slightly encourages TT through L, 25% believe that SIP has no impact on TT through L.	75% believe that SIP has no impact on TT through L, 25% do not know.
	I	All believe that SIP strongly encumbers TT through I.	All believe that SIP strongly encumbers TT through I.	75% believe that SIP slightly encumbers TT through I, 25% believe that SIP slightly has no impact on TT through I.
Pm	IT	33% believe that SIP strongly encourages TT through IT, 33% believe that SIP slightly encourages TT through IT, 33% believe that SIP has no impact on TT through IT.		17% believe that SIP strongly encourages TT through IT, 33% believe that SIP slightly encourages TT through IT, 50% believe that SIP has no impact on TT through IT.

Table 11 Opinions about impact of stronger IPRs protection on technology transfer through different channels (continued)

Industries	Channels	Big firms	Medium firms	Small firms
Pm	FDI	17% believe that SIP strongly encourages TT through FDI, 33% believe that SIP slightly encourages TT through FDI, 50% believe that SIP has no impact on TT through FDI.		All believe that SIP has no impact on TT through FDI.
	L	33% believe that SIP strongly encourages TT through L, 33% believe that SIP slightly encourages TT through L, 33% believe that SIP has no impact on TT through L.		33% believe that SIP slightly encourages TT through L, 67% believe that SIP has no impact on TT through L.
	I	All believe that SIP strongly encumbers TT through I.		17% believe that SIP has no impact on TT through I, 33% believe that SIP slightly encumbers TT through I, 50% believe that SIP strongly encumbers TT through I.
Tr	IT	67% believe that SIP strongly encourages TT through IT, 33% believe that SIP slightly encourages TT through IT.		17% believe that SIP strongly encourages TT through IT, 17% believe that SIP slightly encourages TT through IT, 67% believe that SIP has no impact on TT through IT.
	FDI	All believe that SIP strongly encourages TT through FDI.		All believe that SIP has no impact on TT through FDI.
	L	50% believe that SIP strongly encourages TT through L, 50% believe that SIP slightly encourages TT through L.		33% believe that SIP slightly encourages TT through L, 67% believe that SIP has no impact on TT through L.

Table 11 Opinions about impact of stronger IPRs protection on technology transfer through different channels (continued)

Industries	Channels	Big firms	Medium firms	Small firms
Tr	I	All believe that SIP strongly encumbers TT through I.		33% believe that SIP has no impact on TT through I, 33% believe that SIP slightly encumbers TT through I, 33% believe that SIP strongly encumbers TT through I.
Tf	IT			All believe that SIP has no impact on TT through IT.
	FDI			All believe that SIP has no impact on TT through FDI.
	L			All believe that SIP has no impact on TT through L.
	I			All believe that SIP has no impact on TT through I.
T	IT			All believe that SIP has no impact on TT through IT.
	FDI			All believe that SIP has no impact on TT through FDI.
	L			All believe that SIP has no impact on TT through L.
	I			All believe that SIP has no impact on TT through I.
S	IT	50% believe that SIP slightly encourages TT through IT, 50% believe that SIP has no impact on TT through IT.	50% believe that SIP strongly encourages TT through IT, 25% believe that SIP slightly encourages TT through IT, 25% believe that SIP has no impact on TT through IT.	25% believe that SIP slightly encourages TT through IT, 75% believe that SIP has no impact on TT through IT.
	FDI	50% believe that SIP slightly encourages TT through FDI, 50% believe that SIP has no impact on TT through FDI.	25% believe that SIP strongly encourages TT through FDI, 25% believe that SIP slightly encourages TT through FDI, 50% believe that SIP has no impact on TT through FDI.	25% believe that SIP slightly encourages TT through FDI, 75% believe that SIP has no impact on TT through FDI.

Table 11 Opinions about impact of stronger IPRs protection on technology transfer through different channels (continued)

Industries	Channels	Big firms	Medium firms	Small firms
S	L	50% believe that SIP strongly encourages TT through L, 50% believe that SIP slightly encourages TT through L.	25% believe that SIP strongly encourages TT through L, 50% believe that SIP slightly encourages TT through L, 25% believe that SIP has no impact on TT through L.	50% believe that SIP slightly encourages TT through L, 50% believe that SIP has no impact on TT through L.
	I	All believe that SIP strongly encumbers TT through I.		

Source: obtained from questions T19-T22, which are shown in Appendix 6.

Table 11 shows that the technological executives of most big and medium firms in pharmaceutical, chemical, electronic and software sectors considered that stronger IPRs protection had encouraged technology transfer through international trade, FDI and licensing in their firms. Some technological executives of small firms in the pharmaceutical, chemical, electronic and software sectors also believed that stronger IPRs protection had encouraged technology transfer through international trade, FDI and licensing in their firms. The technological executives of all the selected pharmaceutical, chemical and software firms and most electronic firms believed that stronger IPRs protection strongly encumbered technology transfer through imitation in their firms.

The number of technological executives in big and medium machinery, primary metal and transportation equipment firms who considered that stronger IPRs protection had encouraged technology transfer through international trade, FDI and licensing in their firms was less than that of in big and medium pharmaceutical, chemical, electronic and software firms. Only a few technological executives in small machinery, primary metal and transportation equipment firms considered that stronger IPRs protection had encouraged technology transfer through international trade, FDI and licensing in their firms. Some technological executives in small machinery, primary metal and

transportation equipment firms considered that stronger IPRs protection had no impact on technology transfer through imitation in their firms.

All technological executives in the traditional food and textile sectors believed that stronger IPRs protection had no impact on technology transfer through different channels in their firms.

Impact on technology diffusion without IPRs protection

Table 12 Impact on technology diffusion without IPRs protection

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software

Industries	Big firms	Medium firms	Small firms
Ph	Averagely, 45% technology cannot be developed, 20% technology cannot be commercially produced, and 20% technology cannot be transferred from foreign countries.	Averagely, 47.5% technology cannot be developed, 11.25% technology cannot be commercially produced, and 20% technology cannot be transferred from foreign countries.	Averagely, 22.5% technology cannot be developed, 7.5% technology cannot be commercially produced, and 5% technology cannot be transferred from foreign countries.
C	Averagely, 67.5% technology cannot be developed, 10% technology cannot be commercially produced, and 32.5% technology cannot be transferred from foreign countries.	Averagely, 55% technology cannot be developed, 10% technology cannot be commercially produced, and 22.5% technology cannot be transferred from foreign countries.	Averagely, 32.5% technology cannot be developed, 7.5% technology cannot be commercially produced, and 17.5% technology cannot be transferred from foreign countries.
E	Averagely, 45% technology cannot be developed, 16.67% technology cannot be commercially produced, and 21.67% technology cannot be transferred from foreign countries.		Averagely, 31.67% technology cannot be developed, 9.17% technology cannot be commercially produced, and 8.33% technology cannot be transferred from foreign countries.

Table 12 Impact on technology diffusion without IPRs protection

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software

Industries	Big firms	Medium firms	Small firms
M	Averagely, 30% technology cannot be developed, 2.5% technology cannot be commercially produced, and 12.5% technology cannot be transferred from foreign countries.	Averagely, 22.5% technology cannot be developed, 0% technology cannot be commercially produced, and 5% technology cannot be transferred from foreign countries.	Averagely, 0% technology cannot be developed, 0% technology cannot be commercially produced, and 0% technology cannot be transferred from foreign countries.
Pm	Averagely, 25% technology cannot be developed, 8.33% technology cannot be commercially produced, and 8.33% technology cannot be transferred from foreign countries.		Averagely, 13.33% technology cannot be developed, 0% technology cannot be commercially produced, and 5% technology cannot be transferred from foreign countries.
Tr	Averagely, 30% technology cannot be developed, 5% technology cannot be commercially produced, and 15% technology cannot be transferred from foreign countries.		Averagely, 11.67% technology cannot be developed, 2.5% technology cannot be commercially produced, and 6.67% technology cannot be transferred from foreign countries.
Tf			Averagely, 0% technology cannot be developed, 0% technology cannot be commercially produced, and 0% technology cannot be transferred from foreign countries.
T			Averagely, 0% technology cannot be developed, 0% technology cannot be commercially produced, and 0% technology cannot be transferred from foreign countries.

Table 12 Impact on technology diffusion without IPRs protection (continued)

Industries	Big firms	Medium firms	Small firms
S	Averagely, 45% technology cannot be developed, 15% technology cannot be commercially produced, and 5% technology cannot be transferred from foreign countries.	Averagely, 27.5% technology cannot be developed, 12.5% technology cannot be commercially produced, and 10% technology cannot be transferred from foreign countries.	Averagely, 15% technology cannot be developed, 5% technology cannot be commercially produced, and 0% technology cannot be transferred from foreign countries.

Source: obtained from questions T23-T25, which are shown in Appendix 6.

From table 12, it can be seen that the percentage of technologies that could not be developed, be commercially produced, or be transferred from foreign countries in pharmaceutical, chemical, electronic and software firms was more than that in firms of other selected sectors. Moreover, the percentage of technologies that could not be developed, be commercially produced, or be transferred from foreign countries in big pharmaceutical, chemical, electronic and software firms was more than that in firms of the same sectors.

The percentage of technologies that could not be developed, be commercially produced, or be transferred from foreign countries in machinery, primary metal and transportation equipment firms was less than that in firms of pharmaceutical, chemical, electronic and software sectors. Moreover, technology development, technology's commercial production and technology transfer of some small firms in machinery, primary metal and transportation equipment sectors would not be influenced if there was no IPRs protection.

Technology development, technology's commercial production and technology transfer of all traditional food and textile firms would not be influenced if there was no IPRs protection.

Opinion on the current IPRs policy

Table 13 Opinion on whether the current IPRs protection policy is the best method to protect technology and encourage technology diffusion

Ph: pharmaceutical; C: chemical; E: electronic; M: machinery; Pm: primary metals; Tr: transportation equipment; Tf: traditional food; T: textile; S: software

Industries	Big firms	Medium firms	Small firms
Ph	All believe it is best.	All believe it is best.	All believe it is best.
C	All believe it is best.	All believe it is best.	All believe it is best.
E	All believe it is best.		All believe it is best.
M	All believe it is best.	All believe it is best.	50% believe it is best, 50% do not know.
Pm	All believe it is best.		50% believe it is best, 50% do not know.
Tr	All believe it is best.		All believe it is best.
Tf			All believe it is best.
T			All believe it is best.
S	All believe it is best.	All believe it is best.	All believe it is best.

Source: obtained from questions T26-T28, which are shown in Appendix 6.

Table 13 shows that almost all selected technological executives believe that the current IPRs protection policy was the best method to protect and encourage technological innovations. Only 50% of technological executives of small machinery and primary metal firms did not know whether the current IPRs protection policy was the best method to protect and encourage technology development and diffusion.

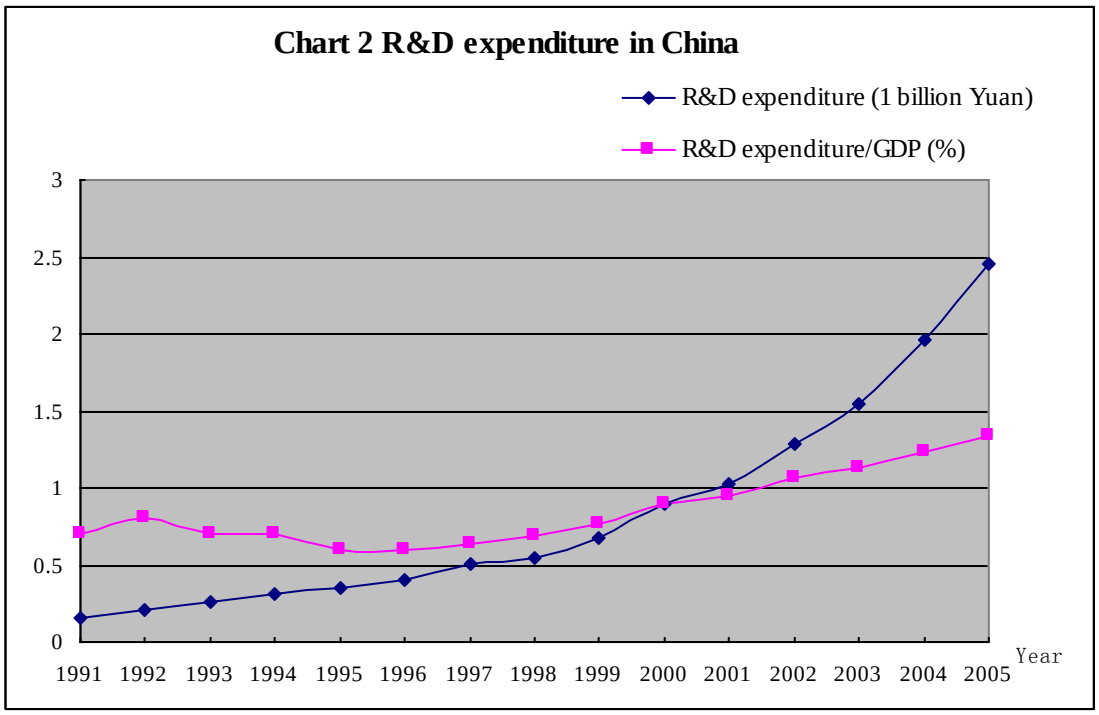
In summary, firstly, most selected big firms were state-owned firms and most selected small firms were private firms. Secondly, pharmaceutical, chemical, electronic, primary metal and transportation equipment firms held comparatively more patented technologies than firms in other sectors. The number of patented technologies held by electronic firms aroused more attention, because it was massive. During the process of face-to-face questionnaires, some executives were asked about reasons for the fact that their firms held so many patented technologies. They said that electronic industry was a kind of new industry in China. This sector had a high density of technologies and technologies got updated rapidly, so firms renewed their patented technologies every

year. In addition, sometimes one kind of patented technology contained different small elements of patented technologies. And these were added to the total amount of patented technology, which made the number of patented technologies held by electronic firms larger than that in other industrial sectors. Primary metal and transportation equipment firms also held many patented technologies. However, according to analytical results of interview data, transportation equipment and primary metal sectors were medium sensitive to IPRs protection policy. Some executives of these sectors were asked during face-to-face questionnaire about this issue. They replied that although they thought that the transportation equipment and primary metal industry were not quite as sensitive to IPRs protection, these sectors had a long history in China and firms, especially some big and state-owned ones, held some patented technologies through the long period of development. Thirdly, executives of all selected pharmaceutical, chemical, electronic and software firms felt that China enforced stronger IPRs protection. All selected pharmaceutical, chemical, software firms, and 83% of selected electronic firms changed their main methods of obtaining technologies after China enforced stronger IPRs protection. 83% of executives of machinery, primary metal and transportation equipment firms felt that China enforced stronger IPRs protection. 67% of machinery firms, 75% of primary metal firms and 83% transportation equipment firms changed their main methods of obtaining technologies after China enforced stronger IPRs protection. 25% of the executives of selected traditional food firms and 33% of the executives of selected textile firms felt that China enforced stronger IPRs protection. All the selected traditional food and textile firms did not change their main methods of obtaining technologies after China enforced stronger IPRs protection. These numbers showed that pharmaceutical, chemical, electronic and software sectors were highly sensitive to IPRs protection; the machinery, primary metal and transportation equipment sectors were medium sensitive to IPRs protection; and traditional food and textile sectors were poorly sensitive to IPRs protection. This is consistent with the analytical results of the interview data. Fourthly, before China enforced stronger IPRs protection, imitation was one of main methods to acquire technologies for most selected firms, and most big firms could acquire technologies through doing R&D; but most small firms

could not do the same. After China enforced stronger IPRs protection, most big firms stopped imitation, but some small firms, still acquired technologies through imitation. Most small firms started R&D by themselves or cooperating with research institutes after China enforced stronger IPRs protection. Some executives were asked about reasons for changing the methods of acquiring technologies during face-to-face questionnaire. They replied that big and medium firms drew a lot of attention from the Chinese government and state-owned firms were directly controlled by the Chinese government, so when China implemented stronger IPRs, these firms did not dare to do imitation any more. The Chinese government did not pay enough attention to the actions of small firms, so these firms sometimes could get away with imitation. Moreover, executives of small firms knew that better IPRs protection had provided more guarantees for their benefit from new technologies, so some of them started to do R&D. However, they did not always have the capacity to do it on their own and turned to cooperate with research institutes for R&D. This is also consistent with analytical results of interview data. Fifthly, most executives considered that stronger IPRs protection had encouraged domestic technology development in China. A few of them considered that stronger IPRs protection had encouraged technology transfer from foreign countries to China. These numbers demonstrated that most executives considered that stronger IPRs protection had a more invigorative impact on domestic technology development than on technology transfer from foreign countries to China. Moreover, most executives believed that stronger IPRs policy strongly encumbered technology transfer through imitation. These are consistent with analytical results of interview data. Sixthly, questionnaire data showed that without IPRs protection, although technology development, technology's commercial production and technology transfer would decrease, there would be still some technologies being developed, being commercially produced and being transferred from foreign countries. This is also consistent with interview data. Finally, most technological executives believed that the current IPRs protection policy was the best method to protect technology and encourage technology diffusion. However, most executives felt that stronger IPRs protection strongly encumbered technology diffusion through imitation. There were some reasons

for the fact that most executives considered the current IPRs protection the best one. The Chinese government always propagandized that current IPRs protection was the best method to protect technology and encourage technology diffusion for China in order to prove that the decision of entering to the WTO and accepting TRIPS was right. There was no other policy available to protect technology in China, which meant there was no other choice for protecting technology, so most executives considered that the current IPRs protection was the best policy to protect technology and promote technology diffusion in China.

6.4. Analysing official statistics

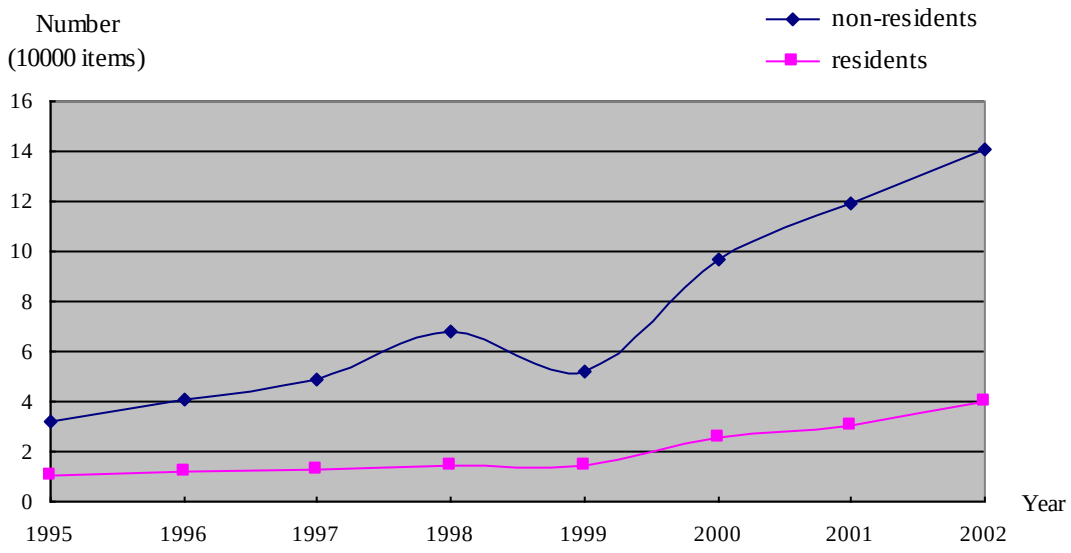


Source: Complied from "China Science and Technology Statistics Data Book 1998-2005" of Ministry of Science and Technology of P.R.C.

Chart 2 shows R&D expenditure and the percentage of R&D expenditure in GDP in China from 1991 to 2005. This chart demonstrates that R&D expenditure increased gradually from 1991 to 2005. R&D expenditure increased sharply from 2001 to 2005. Although the percentage of R&D expenditure in GDP decreased from 1992 to 1999, it increased from 1999to 2005. It is known from the background of IPRs development in

China in chapter four that China started to reform and strengthen its IPRs policy from the early stage of 1980s and its IPRs policy obtained substantial development from 1990s. China acceded to the WTO in 2001 after almost 15 years endeavour. During which time, China's IPRs policy improved greatly. Thus, the increase on R&D expenditure from 1991 to 2005 was consistent with the process that China gradually strengthened its IPRs protection policy for WTO accession. The sharp increase in R&D expenditure from 2001 to 2005 and the rise of the percentage of R&D expenditure in GDP in China from 1999 to 2005 also show that stronger IPRs policy obtained from WTO accession caused more R&D expenditure. Since research process is risky, more investment in R&D means more likelihood of producing new innovations. Therefore, if stronger IPRs protection brings more investment to R&D, it indicates that stronger IPRs protection has positive impact on technology development.

Chart 3 Patent application by residents and non-residents in China

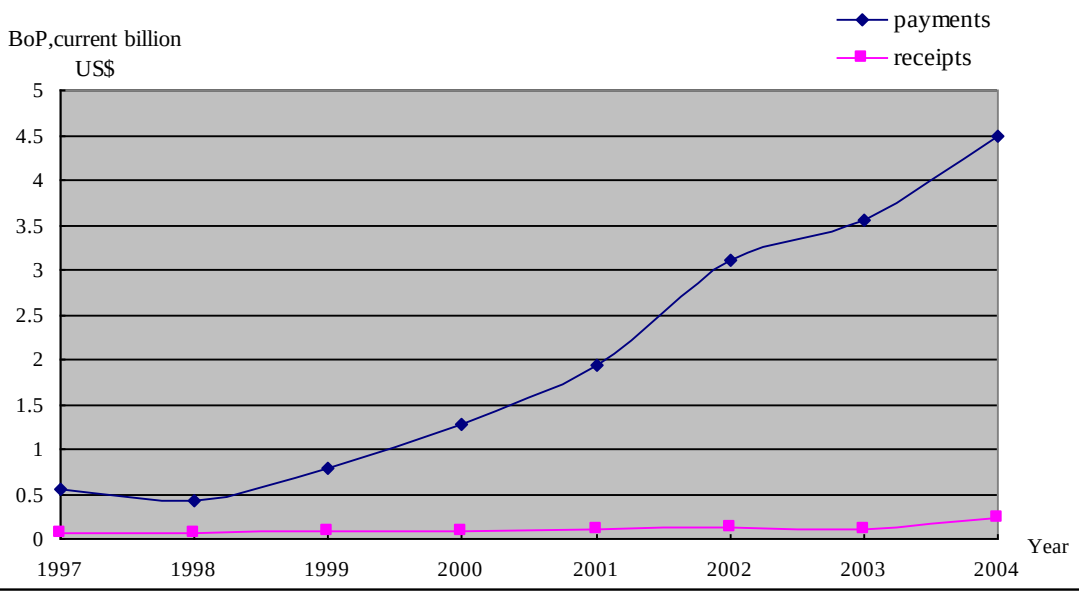


Source: Complied from "World Development Indicator" by World Bank April 2006.

Chart 3 shows that the total numbers of patent applications by non-residents and by residents in China from 1995 to 2002. It is shown that the total numbers of patent applications by non-residents and by residents in China both increased from 1995 to 2002 except a little decrease in 1999, which occurred while the country was applying

stronger IPRs protection policy. This means that based on stronger IPRs policy, there were more patented technologies developed by foreigners and Chinese residents in China from 1995 to 2002. However, it also demonstrated that the total number of patent applications by non-residents in each year from 1995 to 2002 was more than total number of patent applications by Chinese residents. This means that foreigners applied for more patents than Chinese residents in China from 1995 to 2002 with IPRs protection policy improving. These official statistics indicate two aspects. On one hand, based on stronger IPRs protection, more foreign innovators applied for patents in China, which brought a positive impact on technology development and diffusion in China, because the application forms of foreign patents might include some technological information that could help technology diffusion in China and when these patents expire, Chinese firms could use these technologies free of charge. On the other hand, this statistics also showed that the number of foreign patents was much more than that of Chinese patents in China. This means that most technologies were controlled by foreign innovators. In order to get more technologies, Chinese firms still needed to transfer technologies from foreign innovators, who had the right to decide whether or not to transfer technology to Chinese firms and the price of their technologies.

Chart 4 Royalty and license fees payments and receipts for China



Source: Complied from "World Development Indicator" by World Bank April 2006.

Chart 4 displays royalty and license fees payments and receipts by China from 1997 to 2004. It is shown that both royalty and license fees payments and receipts increased from 1997 to 2004, with a slight decrease in payments in 1998 and a slight decrease in receipts in 2003. This increase also occurred when China reinforced its IPRs policy for WTO accession. However, it also shows that the total of royalty and license fees receipt was far less than royalty and license fees payments for China in each year from 1997 to 2004. This meant that with Chinese IPRs protection policy improving, China obtained more money from royalty and license fees but made losses on royalty and license fee payments. The increase in royalty and license fee payments shows two aspects. One was that the number of patented foreign technologies increased because of stronger IPRs protection. This was good for technology diffusion in China. Another one was that the price of patented foreign technologies increased, but the number of patented foreign technologies did not increase as much, based on the same IPRs protection. If the increase in the price of patented foreign technologies was a result of the fact that stronger IPRs protection provided the right for foreign innovators to ask for higher prices for their patented technologies, then the increase in the price of patented technologies could mean that stronger IPRs protection brought a negative impact on technology transfer in China. Because the exact price of each technology transferred from foreign countries to China was not available, the increase in royalty and licensee fee payments could not show the exact impact of stronger IPRs protection on technology transfer in China. However, the statistics of royalty and licence fee payments and receipts in China shows that China made more payments than receipts on royalty and licensee fees with China's IPRs policy becoming stronger.

6.5. Analysing other sources

This research also collected information from other sources, including television programs and interviews with government officials. These sources were not specifically selected from other available ones. These sources used in this section just appeared fortuitously. Any unexpected data was only collected, if it was useful for in this research,

so, this part summarizes the analytical results for these sources.

Living History program in Hong Kong Star TV

On June 6th 2007, the program of Living History of the Star TV invited composer Haiying Li. During the interview, this composer said that copyright protection in China was not very good; however, he would still produce new songs and new music. He also said that his work would not be affected by IPRs protection policy. Producing new songs and music was one part of his life according to his representation.

This material showed that some authors and composers do not pay attention to IPRs protection and they just want to produce more works, which was an important part pursued by them in their whole lives. This information proved that some authors would still produce more works without good IPRs policy.

CCTV News program in China Central Television 1 (CCTV1)

On June 16th 2007, CCTV News introduced that a Chinese firm took about two years to learn and absorb all relevant technologies for a gas-fired set from General Electric of the USA through using the market to exchange their technology. Although the American firm tried to use technologies to control China, the potential large market was one of the main factors attracting foreign technologies to China. However, it also showed that without IPRs protection reform in China, it was impossible for China to develop technological cooperation with foreign companies and transfer technology from foreign countries.

This material provided four important points for this research. Firstly, China's enforcing stronger IPRs protection gave an opportunity for developing technology cooperating with foreign companies and transferring technology from foreign countries. Secondly, foreign countries still set many restrictions to prevent Chinese firms from learning their technologies, especially the high technologies in order to control Chinese technological development. Thirdly, the ability of Chinese firms and people for developing and

absorbing new technology was enhanced greatly. And lastly, China's big market was one of the most important reasons to attract foreign companies to transfer their technologies to China.

The first interview with a government official

This interviewee worked in the government department, whose main responsibility was to promote trade and communications among different kinds of Chinese firms. He acknowledged that the "open market" and other policies that promoting foreign trade were important points to attract foreign companies to put their products into Chinese market, which could also encourage technology transfer to China. Moreover, sometimes these policies could had more important effects than IPRs protection.

The second interview with a government official

This interviewee worked for the department that was in charge of administrating state-owned companies in China. The interviewee said that state-owned firms in China paid more attention to IPRs protection, because they had enough capital and the support from the Chinese government. Private firms usually could not invest a lot on R&D because most Chinese private firms were small-scale firms that did not have enough capital for research. Moreover, firms in the electronic sector and the pharmaceutical sector paid more attention to IPRs protection, because products in these two sectors advanced very quickly. This interviewee also considered that firms in the traditional food, textile and rubber sectors did not pay attention to IPRs protection because they were high labour intensive rather than high technology firms.

6.6. Conclusion

To conclude, this chapter provides the analytical results for all kinds of fieldwork data, including interview data, questionnaire data, official statistics and information from other sources. It shows that China enforced stronger IPRs protection since the country tried to accede to the WTO, which were perceived by most technological executives in

selected industries except the traditional food and the textile industries. Enforcing stronger IPRs protection had both positive and negative impacts on technology diffusion in China. The impact of stronger IPRs protection on technology diffusion varied with different industries, different sizes, different legal statuses of Chinese firms and other relevant policies in China. This chapter has analysed different kinds of data obtained from fieldwork. It does not apply relevant arguments to analyse the results. The next chapter will focus on theoretical analyses of the fieldwork results using relevant arguments.

Chapter 7

Theoretical analyses of fieldwork results

7.1. Introduction

Based on the analytical results for all kinds of fieldwork data obtained in chapter six, this chapter focuses on the theoretical analysis of the fieldwork results. The main purpose of this chapter is to apply the relevant theories and arguments related to IPRs protection and technology diffusion to analyse the fieldwork results. This chapter combines the summary of different fieldwork data in order to compare them and draw results for fieldwork analyses, then applies relevant theories and arguments to do theoretical analyses of the fieldwork results. It uses arguments about IPRs protection and domestic technology development to analyse fieldwork results to show the similarities and differences between the fieldwork results and the relevant literature. It also explores some arguments about the relationship between IPRs protection and technology diffusion in China. Then this chapter applies arguments to the relationship between IPRs protection and technology transfer in different aspects to analyse the fieldwork results to illustrate the similarities and differences between these research results and other relevant arguments.

7.2. Combination of different analytical results

Combining the analyses of different data, including interview data, questionnaire data, official statistics and other sources, there are some important points that can be generalised.

1) While trying to accede to the WTO, China reinforced its IPRs protection. This change was experienced by all kinds of executives in the selected firms except the traditional

food and the textile firms. However, executives of these firms also got to know about IPRs reform from other channels, such as the promulgation of government regulations. This point was gathered from interview and questionnaire data. One may argue that China's IPRs protection policy, especially the enforcement of IPRs protection in China is still weak compared with IPRs protection in developed countries. This is true. China's IPRs protection policy, especially the enforcement of IPRs, is not as good as that in the developed countries. However, the change and improvement of IPRs protection policy and its enforcement in China should be noted. The legal regulations and enforcement on IPRs protection policy in China turned from none to its current state, which is a great enhancement for China.

2) Firms in different industrial sectors had different sensitivities to IPRs protection. In general, firms in the pharmaceutical, chemical, petroleum, electronic and software sectors had high sensitivity to IPRs protection; firms in the machinery, primary metal and transportation equipment sectors had medium sensitivity to IPRs protection; and firms in traditional food and textile sectors had low sensitivity to IPRs protection. This was demonstrated from interview and questionnaire data as well as other sources.

3) Big firms and state-owned firms paid more attention to IPRs protection, while the degree of concern to IPRs protection by small firms and most private firms was less in comparison. This point was learned from interview, questionnaire data and other sources.

4) Stronger IPRs protection in China pushed different kinds of firms to input more money, labour and sources into R&D, which was gathered from interview, questionnaire data and official statistics. Stronger IPRs protection also increased the total amount of domestic technology being developed, which was learnt from interview and questionnaire data as well as official statistics. In fact, stronger IPRs protection had encouraged more domestic technology development than technology transfer. According to the fieldwork, most technological executives explained that before China strengthened its IPRs protection, foreign firms had already required protection of their

technologies by applying foreign IPRs protection at the time of negotiating with Chinese firms about transferring technology to China through different legal channels. Contracts were usually used to ensure that foreign IPRs protection was applied to technologies transferred to targeted Chinese firms. Thus, even before the country made stronger IPRs protection, Chinese firms still could get some technologies transferred from foreign firms. However, at the time, foreign firms could not get good protection for their technologies from relevant Chinese firms except those who obtained their transferred technologies through legal channels. This showed that the environment of IPRs protection in China before the country made stronger IPRs policy was not good. After China reinforced stronger IPRs protection, IPRs protection environment in China became better. Foreign firms could not only obtain IPRs protection through contract terms, but also use existing Chinese IPRs regulations to get protection for their technologies from other Chinese firms that did not receive their technologies. It is worth mentioning that the amount of technology transferred from foreign countries did not increase greatly after China reinforced its IPRs protection, as Chinese firms had already had some technologies transferred even before the reinforcement. For domestic technology development, technological executives thought that before China made stronger IPRs protection, there was no good protection on technologies for Chinese firms, which led to the fact that new technologies could not bring great benefit for Chinese firms, as a result, firms had no motivation to do R&D. After the country tried to join the WTO and made stronger IPRs protection, technology protection improved gradually and Chinese firms were able to get benefit from new technologies they developed. Moreover, the number of researchers and the capacity of doing R&D in China were both increasing. There was a great increase in domestic technology development after China tried to accede to the WTO and implemented stronger IPRs protection. These could be learnt from interview and questionnaire data.

5) Stronger IPRs protection also had negative impacts on technology development and diffusion. It pushed most firms to invest in preventing pirating of their technologies. It also greatly encumbered technology development and diffusion through imitation.

Stronger IPRs protection also provided the opportunities for firms to delay the commercial production of their new technologies. Moreover, although there were more technologies transferred from foreign countries to China based on stronger IPRs policy, most of these were either basic technologies, whose development depended on further technology transfer from foreign firms, or technologies which could not bring great benefit. Chinese firms needed to pay more for technology transfer from foreign countries. These points were gathered by interview, questionnaire data and official statistics.

6) Without good IPRs protection and with many imitations, some firms could still obtain benefit from their technologies and there was still some technology transfer because China's big open market and other favourable policies attracted foreign companies to transfer their technologies to China. Moreover, without good IPRs protection, some authors still wanted to publish their works. These could be found from interview, questionnaire data and other sources.

7) Other policies, including the "Open Door" policy, policies that encouraged economic development in China, policies that encouraged R&D, favourable terms in foreign investment policies, policies that supported the development of some industries, and China's big open market, also promoted technology development and diffusion in China.

8) Most of the selected interviewees in this fieldwork considered that the current IPRs protection was the best policy to encourage technology development and diffusion. Almost all interviewees believed that they were better off with stronger IPRs policy, that it was necessary to further reinforce IPRs protection in China, and that there was no disadvantage in the current IPRs system. However, when talking about detailed impact on technology diffusion by the current IPRs policy, they could also tell that there was a negative impact brought by the current IPRs policy on technology diffusion. This phenomenon showed that government propaganda and conventional ideas made people believe that the current IPRs policy was the best method to protect technology and

encourage technology diffusion. Moreover, because there were no other feasible policies available, people believed that the current IPRs policy was the best one.

To sum up, the Chinese government enforced stronger IPRs policy since the country tried to enter the WTO. This had encouraged the domestic technology development in China more than that of technology transfer. It also had some negative impact on technology diffusion in the country. Moreover, the impact of IPRs policy on technology diffusion was different in different industries, different size and legal status of firms and in different conditions of other relevant policies.

7.3. Analysing fieldwork results using arguments about IPRs and domestic technology development

Firstly, utilitarians discussed IPRs protection from the economic view. The fieldwork results demonstrate both similarities and differences with utilitarian arguments. As David (1993) summarised, utilitarians believed that information and knowledge as commodities had characteristics like "public good". Without special measures to protect information as a commodity, information itself will be automatically diffused and people can know and use it without paying anything, therefore, utilitarians thought that it was better to provide a monopoly power obtained from IPRs protection to the creators of technologies to help securing their benefit from innovating technological information, otherwise innovators of technological information would not want to do R&D any more because they could not obtain enough return to cover their cost. This utilitarian argument indicates three points. 1. Utilitarians considered that it was easy to obtain technology and it costs nothing to know and use technology, if there was no special measure to protect the technology, since technological information had characteristics like public goods. The fieldwork results show that without special protection, some technologies, such as pharmaceutical, chemical and software technology, could be obtained easily through reverse engineering. However, not all kinds of technologies could be acquired easily. According to fieldwork results, technologies in machinery and

transportation equipment sectors were not so easy to obtain. Moreover, it is also known from the fieldwork results that there was a cost to know and use technological information invented by other people. Imitators still needed to do reverse engineering, which incurs costs. Interviewees said that it was needed to do reverse engineering to learn and get technologies developed by others even if there was no IPRs protection on technology or no restriction on imitation. But they admitted that the cost of reverse engineering was lower than the cost of R&D carried out by the inventors. And for this, many firms were willing to get technologies through imitation to cut the cost. 2. Utilitarians also believed that without the monopoly power of IPRs protection, technology innovators could not obtain enough return to cover their cost. These fieldwork results demonstrate that without IPRs protection and even if technologies were imitated by others, not all firms would lose their benefit to cover their costs in doing R&D. If technologies were imitated by others, firms with production capability that wass quite difficult to obtain in a short time, could still receive enough financial return to cover the cost of R&D. However, firms with production capability that was easy to obtain in a short time, such as software companies and small electronic companies, might not be able to cover the cost of R&D. 3. Utilitarians also thought that without IPRs protection, technology creators would not want to do R&D any more. This research obtained different results on this point. Some interviewees considered that their firms would still do R&D on new technology even if there was no IPRs policy. And some authors, who only wanted to make their names known, would still publish their works even when pirated publications appear in the market. In addition, some people put forward some questions on the utilitarian view. 1. David (1992:34) summarised that IPRs protection policy provided monopoly power to innovators, which caused innovators not to worry about the appearance of potential entrants through imitating existing innovations. With good IPRs protection, innovators could add additional prices to their innovative productions and consumers had to pay higher price on the innovative products (McCulloch, Winters and Cirera, 2002:210). This can lead to the fact that benefit gained by society and consumers from using innovations will be lower than that in competitive markets, which is called the deadweight burden problem (David,

1993:34). This fieldwork results found the same problem. It is shown from the fieldwork results that if technology was imitated by others, firms with production capability that was quite difficult to obtain in a short time, could still have benefit to cover the cost of R&D. These firms did not need IPRs protection to ensure their return to cover their research costs. However, with monopoly power provided by better IPRs protection policy, these firms could increase the price of their technological products to obtain more benefit, in which case, IPRs protection policy became a method of earning extra profit. 2. David (1993:35) also indicated that many new innovations needed previous research results and inventions. If these have been protected by IPRs protection, researchers would need to pay royalties, which are not affordable for all researchers, and this may slow down development and research (David, 1993:35). This problem is the so called intermediate information inputs problem. The fieldwork results also prove this problem. Some interviewees said that their firms could implement and improve some patented technologies but because the owners of these patented technologies did not want to sell and the patent were still up-to-date; these firms had to wait until these patents expire. This illuminated the problem of intermediate information inputs when using IPRs to protect technology.

Secondly, some people were against IPRs protection policy. Boldrin and Levine (2005:8) believed that the intellectual monopoly brought by IPRs protection policy created "many social costs". They considered that intellectual monopoly was not necessary and competition could provide stable growth in innovations. The fieldwork results do not fully support this argument. The fieldwork results show that if technology was imitated by others, firms whose production capability was quite difficult to obtain in a short time could still have benefit to cover the cost of doing R&D. IPRs protection was just used by these firms to earn extra profit. By contrast, firms whose production capability was easy to obtain in a short time, could not obtain benefits to cover their R&D costs, if their technology was imitated by others. If there was no IPRs protection, R&D in these firms would reduce greatly and these firms would turn to imitation to cut their costs. IPRs protection was therefore necessary for these firms to gain benefit and stimulate

innovative activities. Moreover, this fieldwork shows that although the number of technologies would reduce without IPRs protection, some technologies would still be developed in those firms mentioned in this fieldwork. This means that in competitive markets and without IPRs protection, there are still some technologies available.

Thirdly, Thurow (1997:95-103) believed that a uniform size of IPRs protection system could not fit all types of inventions in different industries and conditions. He suggested that there should be different types of patents according to different industries, different kinds of knowledge and different "types of innovators" (Thurow, 1997:95-103). These fieldwork results show that different industries had different sensitivities to IPRs policy in China. The IPRs policy had different impacts on technology development and diffusion in different industries. For some industries, such as the pharmaceutical, chemical, petroleum, electronic and software industries, IPRs protection was widely applied and the change of IPRs protection had great impact on technology development and diffusion. However, for some industries, such as the traditional food and textile industries, IPRs protection was of little use. These fieldwork results show that IPRs protection policy had different impacts in firms with different kinds of production capability. This fieldwork results also show that the impact of IPRs policy on technology diffusion in China was different in different legal statuses and different sizes of firms. Moreover, other relevant policies also had influences on the relation between IPRs protection and technology diffusion. These fieldwork results support Thurow's (1997) arguments. It is reasonable to set up an alternative IPRs protection system to embody different patents according to different industries, different knowledge, different innovators and different conditions of innovations.

Fourthly, some people found that the relation between IPRs protection and domestic technology development depended on other factors, such as different industries and other policies. 1. A research done by Levin et al (1987) showed that in pharmaceuticals and chemicals industries, R&D executives paid more attention to patents, which meant that patents had a crucial effect in encouraging innovative activities in these two

industries. In other industries, patents had not been important in protecting productions and producing processes (Levin et al, 1987:796-797). Mansfield (1986) found that patents were quite significant for the development or commercial introduction of 30% or more of innovations in pharmaceuticals and chemicals industries; was important for the development and commercial introduction of about 10-20% of innovations in industries of "petroleum, machinery and fabricated metal products"; and had only limited effect on development and commercial introduction in the "electrical equipment, office equipment, motor vehicles, instruments, primary metals, rubber and textiles" industries (Mansfield, 1986). For the industries of "office equipment, motor vehicles, rubber and textiles", R&D executives of these firms all agreed that patents were not significant for innovation development and their commercial production (Mansfield, 1986). Taylor and Silberston (1973) found that R&D in the pharmaceutical and chemical industries relied on patents, while R&D in mechanical engineering and electronics industries did not rely on patents. These fieldwork results show that IPRs protection policy had different impacts in different industries, which was similar to research done by Levin et al (1987), Mansfield (1986) and Taylor and Siberston (1973). However, these fieldwork results indicate that industries' sensitivities to IPRs protection policy were not exactly the same as the arguments of Levin et al (1987) and Mansfield (1986). These fieldwork results show that firms in the pharmaceutical, chemical, petroleum and electronic sectors were highly sensitive to IPRs protection; firms in the machinery, primary metals and transportation equipment sectors were medium sensitive to IPRs protection; firms in traditional food and textile sectors were poorly sensitive to IPRs protection policy; and publishing and software sectors had great interest with copyright in IPRs protection. The reasons for this difference were the following, according to the explanation of technological executives attended the interviews. In China, the petroleum sector was considered important to the security for the whole nation, and the Chinese government had invested a lot in R&D in this sector, so there were a lot of patented technologies in this sector and different kinds of Chinese petroleum firms had heated competition in doing R&D. Therefore, these firms cared about IPRs protection more and they were quite sensitive to IPRs policy. The electronic

sector in China was a relatively new and high-tech industrial sector, and the government also encouraged the development of this sector. Moreover, products and technologies in this sector updated rapidly. Therefore, this sector held comparatively more technologies than other sectors in China. Consequently, Chinese electronic firms paid more attention on IPRs protection and were quite sensitive to IPRs protection. Stronger IPRs protection brought more technological changes in sectors that were quite sensitive to IPRs protection; but less in sectors that were medium sensitive to IPRs protection policy; and could not encourage technology development in sectors that were low sensitive to IPRs policy. 2. Maskus (1997:8) fiound that the impact of IPRs protection also had indirect relationship with other policies, such as "trade and investment policies, industrial policies, including research and production subsidies, public-health and environmental regulations, and commercial controls". These fieldwork results also prove this argument. This fieldwork finds that other Chinese policies also promoted domestic technology development based on stronger IPRs protection. Interviewees said that the "Open Door" policy, policies that encouraged economic development, policies that encouraged R&D and policies that encouraged some industries' development boosted domestic technology development. Stronger IPRs protection encouraged domestic technology development in China. Moreover, the Chinese government also implemented a policy of encouraging R&D, such as providing prizes for innovating firms, which accelerated the speed of domestic technology development in China. Interviewees said that industrial policies, such as those that encouraged the development of the electronic industry and software industry, also promoted technology development and diffusion in relevant industries.

Finally, Bessen and Maskin (2000) indicated that if the innovation was "sequential and complementary", patent rights might decrease "overall innovation". They believed that if the innovations were "sequential and complementary", imitation would have positive impact on encouraging inventions and stronger IPRs protection would restrict innovations. This research obtains similar result with this argument. Some interviews expressed that because of stronger IPRs protection, many firms tried their best to protect

their technologies. It was more difficult to obtain patented technology. Without some important information in previous innovations, some improvement and new technology based on previous innovations could not be realized. This made the pace of improving technology slower than before.

7.4. Analysing fieldwork results using arguments about IPRs and technology transfer

Firstly, some people put forward some possible problems aroused by IPRs protection from the utilitarian view. 1. McCulloch, Winters and Cirera (2002:210) generalised, based on good IPRs protection, that innovators could add additional prices to their innovative productions and consumers had to pay higher prices for the innovative productions. These fieldwork results show this problem. Most interviewees stated that based on stronger IPRs protection, foreign firms could increase the prices of their technologies when transferring their technologies to Chinese firms. 2. David (1993) summarised the intermediate information inputs problem. This means that if previous research results and inventions have enjoyed IPRs protection, researchers need to pay royalties for previous inventions. Some researchers cannot afford the royalty, which can lead to slower development of the research process. This fieldwork also detects this problem in technology transfer from foreign countries to China. Some interviewees said that based on stronger IPRs protection, important technologies, which could bring great profit, were strictly controlled by the firms who owned them. Although there were more technologies transferred from foreign countries to China after the country reformed its IPRs policy, most of these technologies were either basic technologies, whose development depended on further technology transfer from foreign firms, or technologies that could not bring great benefit. Without further technology transfer from foreign countries, Chinese firms could not obtain great benefit, nor could they do further R&D. However, sometimes, foreign firms did not want to transfer their important technologies to Chinese firms, or set high prices for transferring their important technologies, which were not affordable to these Chinese firms. Based on stronger IPRs

protection, imitation was no longer an option to obtain these important technologies and this delayed the research process of these firms.

Secondly, Maskus (1998:134) believed that IPRs protection had two different and opposite influences on technology transfer. On one hand, IPRs protection can promote technology transfer, because domestic companies can utilize information in IPRs applications to do follow-up innovations without infringing the original right on patented technologies. On the other hand, IPRs protection can also reduce the speed of technology transfer and diffusion, because IPRs protection gives owners of innovations the capability to prohibit local firms from using significant technologies by adding restrictive articles in licensing agreements. This fieldwork also shows that stronger IPRs protection had two opposite impacts on technology transfer in China. This fieldwork indicated that on one aspect, stronger IPRs protection attracted foreign firms to transfer their technologies to Chinese firms, because it provided better protection for their technologies. Interviewees expressed another aspect that stronger IPRs protection, which offered power to foreign firms to control their technologies through reducing the chance of imitation, also gave foreign firms the ability to increase the prices of their technologies, and add restrictive articles to preserve their core technologies when transferring their technologies to Chinese firms. This brought a negative impact on technology transfer and diffusion.

Thirdly, some people believed that stronger IPRs protection brings negative impacts on technology transfer. 1. As Kanwar and Evenson (2003:237) summarised, Roffe deemed that IPRs protection, especially patents, could result in patent abuse in developing countries. “Inadequate disclose” of patent is a common form of patent abuse, which is described in detail in the third Chapter (Kanwar and Evenson, 2003:237). Without significant knowledge of the invention, even skilled persons cannot acquire the innovation after the patent expires, which prohibits the development of domestic technology. This fieldwork result also proves this issue. Some interviewees said that their firms could not get the core technologies when transferring technology from

foreign firms through different channels. They also expressed that without the core technologies, even if the patent expires, their firms could not obtain the technologies or do improvements based on the technologies. 2. Mengistie (2003:11-13) considered that under IPRs protection, foreign technology holders could use unreasonable articles in licensing contracts to restrict technology transfer to developing countries, such as prohibiting licensees doing technological development based on licensed technologies, regulations that licensees had obligations to transfer their improvements based on licensed technologies to licensers and restricting firms of developing countries using technology even after the patent expires. Under patent protection, increases in the prices of foreign technologies and foreign innovative products also have negative impact on technology transfer to developing countries. These phenomena are also shown in this research. Most selected interviewees indicated these points during doing interviews. Some executives said that foreign firms used restrictive articles to prevent Chinese firms from doing technological development based on technologies transferred from them. Even after agreeing to transfer their technologies to Chinese firms, foreign firms still tried to prevent Chinese firms from learning about their core technologies. Although stronger IPRs protection policy gave more power to foreign firms to set restrictions and unreasonable articles in transferring their technologies to China, Chinese firms have great abilities to learn and absorb new technologies. However, stronger IPRs protection made the process of learning and absorbing foreign technologies much longer than before. Through the analyses of official statistics, it is shown that China spent increasingly more money in royalty and license fees payments with Chinese IPRs protection policy turning better.

Fourthly, some people considered that the relation between IPRs protection and technology transfer from foreign countries to China depended on other factors. Falvey and Foster (2005:7) believed that stronger IPRs protection encouraged technology transfer and diffusion in countries, which had good “capacity for innovation or imitation”, take open trade policies, and have large market size. Without these conditions, technology transfer and diffusion would tend to be restricted in a country.

This means that it is possible that stronger IPRs protection can encourage technology transfer and international technology diffusion through the channels of imports, FDI, licensing and foreign patenting. However, this is just a possibility and it depends on other factors. This fieldwork also proves this argument. Interviewees considered that the policies for encouraging foreign investment in China also played an important role in promoting technology transfer from foreign countries to China. This fieldwork also indicated that China's big market also attracted foreign firms to transfer their technologies to China through different channels even if China IPRs protection was not as good as that of their own countries, because the big market could bring great benefit to these firms. China's open and big market attracted foreign firms to do different kinds of investment in China. Some foreign firms directly invested in China and set up a firm. Chinese workers working in the firm could learn some technological information about foreign technologies. Some foreign firms used their technologies as investment to cooperate with Chinese firms, and these firms could then use these technologies. Other foreign firms wanted to sell their technological products in China and the technology contained in these products could be learnt by Chinese firms. All of these different kinds of activities could bring positive impacts on technology diffusion in China.

7.5. Arguments about IPRs and technology diffusion in China

There are some Chinese articles. Although these papers did not aim to investigate the general relationship between IPRs protection and technology diffusion in China, they involved some useful arguments about this research. The useful arguments in these papers can be applied to make comparisons with the results of this research to generalise the unique and specific conclusions obtained in this research, which are also the contributions of this research. Therefore, these Chinese works are very important

Some researchers argued that IPRs protection encouraged technology development and diffusion in China in different aspects.

1) Deli Yang (2003) investigated the history of IPRs protection development, including

the evolutionary change before and after the "Open Door" policy in China. He also analysed the reasons for improving IPRs protection in China. Yang (2003) also explored the effect of the change on IPRs protection in China. Yang (2003) summarized that the improvement of IPRs protection greatly encouraged the use of the IPRs system, which showed the tremendous technological development in China. He mentioned that the applications for invention patents by residents and non-residents in China both increased from 1990s, although the applications for invention patents by non-residents were more than those by residents in China. Moreover, Chinese people "are making progress in technology development" during the improving of IPRs protection policy, because "the gap between foreign and local invention patent holders is gradually narrowing down from 1995" (Yang 2003:139). The lower level of innovative activities was also encouraged by the change of IPRs protection policy, because the utility model increased dramatically in China during the change of IPRs policy. "Major developed countries", especially the USA, Japan and EU, played an important role in improving technology development in China through the data of foreign intellectual property flows to China (Yang 2003:139). In addition, with the improvement of IPRs protection policy, copyright protection also improved in China. Yang (2003: 141) also demonstrated the imperfection of current IPRs protection system in China, including "inadequate punishment for counterfeiting and plagiarism, unreasonable restrictions on copyright holders' rights, limited protection on integrated circuits and lack of the necessary control of the abuse of intellectual property". Thus, he pleaded for constant improvement in the legal regulations and enforcement of current IPRs protection system in China.

2) Yueh (2009:304) applied "a simple model of patent production in China" obtained from the patent regulation system to explore the impact of patent system and IPRs protection on innovation in China while China reformed its IPRs system. Yueh (2009) found that innovations protected by patents had increased in China while the reform period, although the IPRs system was still imperfect. In spite of the fact that innovation was not only determined by IPRs regulation system, but also determined by other

factors, such as “R&D personnel” and “provincial traits”, patent regulations in China “produced a steady rate of growth of patents across the country” (Yueh 2009:312). This shows that the reform of IPRs protection system including the patent system, indeed encourages the development of innovations captured by patent in China.

3) Meyer (2001:140) pointed that China created a favourable environment for multinational corporations in developed countries to do business through “transferring new technology” in China. The fact that IPRs protection in China was becoming better respected plays an important role in creating the favourable environment for transferring technology from multinational corporations to China. This implies that Meyer believed that better IPRs protection encouraged technology transfer from foreign countries to China.

4) Awokuse and Yin (2010:1) used econometric methods to discuss the influence of IPRs protection regulations reform on “bilateral trade flows” in China. They applied “trade data for 20 product sectors” from “36 countries, including 21 OECD countries and 15 non-OECD countries”, which were “top trading partners with a significant number of patent application filings in China” to analyse the impact of IPRs reform in China’s bilateral trade flows (Awokuse and Yin 2010:5). They also divided product sectors into two kinds of groups: “knowledge-intensive products (mainly outputs from science-based industrial sectors) and non-knowledge-intensive products (mainly outputs from traditional or low-tech industrial sectors)” (Awokuse and Yin 2010:5). They found that stronger IPRs protection had positive impact on imports from foreign countries to China.

5) Awokuse and Yin (2009:2) used “a panel data from 38 countries” to explore the influence of IPRs protection regulation reform on encouraging FDI from 1992-2005 in China. They also investigated “the possibility that effect of IPRs protection on FDI may vary by the level of economic development in partner countries” (Awokuse and Yin 2009:2). They found that stricter IPRs protection played a very positive and important role in encouraging and attracting FDI, although “market size, regional integration and

transportation and trade costs" were also the factors that affect the FDI flows in China (Awokuse and Yin 2009:7).

6) Bosworth and Yang (2000) investigated the relationship between IPRs protection law and technology transfer through the channel of licensing activity in China. They believed that whether corporations of advanced countries were more willing to exchange technology with non-advanced countries greatly relied on the existing IPRs protection system that safeguards the benefit of technology holders in non-advanced countries. Moreover, they considered that IPRs protection system should be strong enough and be enforced efficiently in developing countries to encourage technology transfer from developed countries. They explored the important changes of IPRs regulation, analysed the internal and external reasons for the change of IPRs policy, and discussed the influence of new IPRs regulations on intellectual activities as well as on the potential for encouraging licensing in China. More importantly, they investigated the impact of IPRs reform on the "flow of patents, designs, trademarks and utility models" from other countries to China, as these flows were the "forerunners of technology transfer and licensing activities by foreign and Chinese firms" (Bosworth and Yang 2000: 455). They found that although technology transfer via license from the USA and Japan decreased at the beginning of the 1990s because of "political and administrative reasons", with the introduction and improvement of IPRs protection, intellectual property flows from developed countries to China were increased in general, which had the "potential for licensing" chances (Bosworth and Yang 2000: 476). However, they also noticed the weaknesses of current IPRs protection system both in the enforcement and in the legal regulations and suggested doing further improvements on China's IPRs system in order to encourage more technology inflows.

Some researchers argued that IPRs protection could not have positive impacts on technology development and diffusion, especially through FDI.

1) Lanoszka (2003:186) suggested that developed countries desired high levels of IPRs protection in the whole world and developed countries believed that stronger IPRs

protection could bring benefits for economic development in developing countries. Lanoszka (2003) pointed that in the view of developed countries, stronger IPRs protection in developing countries established by TRIPS ensured the benefit for innovators in developed countries, which created a good investment background for corporations in developed countries for FDI in developing countries. Thus, in the view of developed countries, stronger IPRs protection would bring more FDI in developing countries. However, Lanoszka (2003) demonstrated that there was no evidence to support this. Lanoszka (2003) pointed that in the past 20 years, China did not have good IPRs protection, however, the flow of FDI in China had increased dramatically. This means that according to Lanoszka，there was no evidence to prove that stronger IPRs protection in developing countries, such as China, encouraged FDI from developed countries.

2) Yu (2007) indicated in his research on the relationship between IPRs protection and FDI that stronger IPRs protection obtained from IPRs protection reform in China did not attract FDI in China. He found that although IPRs protection in China remained inadequate and the enforcement of IPRs protection in China was not effective compared with that in developed countries, there is still much FDI flowing into China. He (2007:1) explained that the fact that foreign investors were attracted to invest in China was not because of the reform of IPRs protection policy, but because they wanted to take advantage of the lower costs, China' big market, China's "inefficient economic system" and the favourable policies for foreign firms in China. This means that Yu did not believe that stronger IPRs protection could encourage FDI in China.

In general, most researchers supported the idea that IPRs protection reform had encouraged domestic technology development and technology transfer through different channels. However, some researchers pointed out that IPRs protection did not have positive impacts on the flow of FDI to China. FDI is another possible channel to bring technology from foreign countries to China. According to these researchers, IPRs protection did not encourage FDI flows into China, which means that IPRs protection

could not have positive impacts on technology transfer through FDI.

7.6. Unique results obtained in this research

Through comparing this research with previous literatures and arguments, especially the arguments about the relationship between IPRs protection and technology diffusion in China, there are some special unique points generalised from this research. This section explores these unique results summarised from this research.

There are some special results about the relationship between IPRs protection reform and domestic technology development in China. 1. Without IPRs protection, many Chinese firms would still do R&D. Most interviewees considered that new technologies were very important to their firms, and even if there was no IPRs protection available, they would still do R&D. Although in theory, innovators are likely to go on R&D without IPRs protection, previous work has not investigated the change of innovative activities if there is no IPRs protection available, especially in China. This research covered this information both from interviews and questionnaires. 2. For Chinese firms whose production capability was quite difficult to copy in a short period, cost of R&D could be cover from profits, even if their technologies were copied by competitors. But for firms whose production capability was quite easy to be copied in a short period, this was not the case. This means that IPRs protection was only useful for the latter firms to protect their technology from being copied. But for the former, IPRs protection was a method of getting extra benefit by ensuring protection period for their technology and therefore not useful for promoting technology diffusion in these firms. This information was about the impact of imitation, which was obtained from interviews. Previous arguments neither covered this information nor the detailed reasons for the major loss or minor loss of different firms if imitation occurs. 3. In China, the relation between IPRs policy and domestic technology development not only varied with different industrial sectors, but also depended on the size and the legal statuses of Chinese firms. In general, big firms and state-owned firms paid more attention to IPRs protection policy, so they

were comparatively more sensitive to IPRs protection policy. Small firms and private firms did not care about IPRs protection as much, so they were comparatively less sensitive to IPRs protection. The reasons were that big firms drew a lot of attention from the Chinese government and state-owned firms were directly controlled by the government, so these firms had to comply with government's IPRs protection policy strictly. Most of the big firms in China were state-owned firms. The government sometimes did not watch closely the actions of small firms and private firms, so these firms sometimes did not follow government's IPRs policy. Most of the small firms in China were private firms. Some of them still imitated even after China reinforced its IPRs policy. Thus, the change on IPRs protection had obvious impacts on big firms and state-owned firms but not on small or private firms. This point was not demonstrated in other relevant literature or arguments. 4. Although stronger IPRs protection urged big and state-owned firms not to use imitation to get new technologies, many small private Chinese firms still continued with imitation as it played a very important role in promoting technology development and diffusion. The reasons for this were that the enforcement of IPRs protection in China was not as strict as that in developed countries and the consciousness of protecting technology through IPRs legal regulations among different Chinese firms was not as strong as that in developed countries. The Chinese government paid more attention to the supervision of big, famous and state-owned firms. If these firms imitated technologies from other firms, the government would pose large fines on them. For small and private firms, Chinese government could not look upon them and provide strict supervision over them. Moreover, some Chinese firms would not ask for IPRs compensation through legal methods, if imitation did not create great loss for them. Only if imitation brought a great mount of loss or induces the bankruptcy of Chinese firms, would they pay attention to obtaining compensation from the imitative competitors. Thus, this lead to the fact that small and private firm still dared to imitate in China.

There are also some special results about the relation between IPRs protection reform and technology transfer from foreign countries to China. 1. Generally, stronger IPRs

protection increased technology transfer from foreign countries to China through legal and formal channels, such as international trade, FDI, and licensing. Stronger IPRs protection greatly reduced technology transfer from foreign countries to China through imitation. This is quite different from the results obtained by Lanoszka (2003) and Yu (2007), which suggested that IPRs protection had not brought positive impacts on FDI. The interviews and questionnaires obtained in this research proved that all kinds of legal channels of technology transfer, including FDI had been encouraged by stronger IPRs protection in China. The reason was that stronger IPRs protection improved the investment environment in China, which was similar to the argument put forward by Meyer (2001). The improved investment environment attracted foreign firms to invest in China through different channels. 2. Without IPRs protection, some technologies would still be transferred from foreign countries. Even before China made stronger IPRs protection, Chinese firms could get technologies from foreign countries through legal and formal channels. The reason was that before the country implemented stronger IPRs protection, the process of technology transfer from foreign countries had already followed foreign IPRs protection standards at the time. Foreign firms required the application of foreign IPRs protection standards for technology transfer. Therefore, if Chinese firms accepted the need to give IPRs protection to foreign technology using foreign IPRs protection standards at the time, they could get technologies transferred through legal and formal channels from foreign firms. 3. Domestic technology increased faster than that of technology transfer from foreign countries. The reasons were the followings. According to interviewees, stronger IPRs protection policy ensured benefit of developing new technologies. Moreover, the number of researchers and the capacity for doing research and development in China were both increasing. Under stronger IPRs protection, firms were more willing to do R&D, and hence domestic technology developed by Chinese firms showed obvious increases after the reinforcement of IPRs protection. Interviewees indicated that the increase of technology transfer from foreign countries was less than that of domestic technology development in China. 4. The relationship between IPRs protection and technology transfer in China also depended on different industries. Stronger IPRs protection induced more technology transfer in

industrial sectors with high sensitivity to IPRs protection, such as the pharmaceutical, chemical, petroleum, electronic and software sectors. However, it did not have much impact on technology transfer in industrial sectors with low sensitivity to IPRs protection, such as the traditional food and the textile sectors. Moreover, the relation between IPRs protection and technology transfer also depended on the size and legal statuses of Chinese firms. Big firms and state-owned firms were comparatively more sensitive to IPRs protection. Small firms and private firms were comparatively less sensitive to IPRs protection policy. Pervious studies, especially those on the relation between IPRs and technology development in China, did not investigate these factors. 5. Stronger IPRs protection did not influence technology transfer from foreign countries in the petroleum sector as much. This fieldwork shows that because petroleum was a very important product for a nation's security, petroleum technology was strictly controlled by firms and even the government. According to technological executives in the petroleum sector, even after the Chinese government made stronger IPRs protection policy, firms could not obtain significant petroleum technology from foreign countries, since very important technologies were strictly controlled by foreign firms and their governments as well. This point was not found in previous studies.

7.7. Conclusion

To conclude, this chapter combines analytical results of different fieldwork data and then did theoretical analyses of those results using relevant theories and arguments. It shows through combining different fieldwork data that China's trying to accede to the WTO caused China to enforce stronger IPRs protection. Enforcing stronger IPRs protection had both positive and negative influences on technology diffusion in China. Moreover, different sectors, sizes and legal statuses of firms, and other relevant policies also had different impacts on the relation between IPRs protection and technology diffusion in China. This theoretical analysis of fieldwork results embodied both similarities and differences with relevant literatures. It shows some similar points with the Utilitarian view and proved some problems aroused by the utilitarian view, such as

the deadweight burden problem and the intermediate information inputs problem. This fieldwork also proved some points put forward by Boldrin and Levine's against intellectual property argument and Thurow's differentiate patent argument. It also embodies both similarities and differences with relevant literatures on the relationship between IPRs protection and technology diffusion. This chapter also explores some arguments about the relationship between IPRs protection and technology development and diffusion in China. Then, it compares the results obtained from this research with previous studies. These similarities and differences obtained through comparison are the main finding and conclusion for this research. The differences show the unique characteristics related to IPRs protection reform and technology diffusion in China, which also indicate the importance of this research.

Chapter 8

Conclusion

After explaining the main research processes and content, this final chapter states the conclusion of this research. This chapter has three sections. The first section summarizes the whole research. It includes the research question, the purpose of this research, and the processes and a summary of each chapter. The second section explains the main conclusions of this research. The third section is recommendations for future work.

8.1. Research summary

8.1.1. Research question

After almost fifteen years' effort, China acceded to the WTO in 2001. China's entrance to the WTO had brought and continues to bring comprehensive influences on the country, in which the impact on IPRs protection draws many concerns. China reformed and strengthened its IPRs policy in order to join the WTO under pressure from the developed countries, especially the USA. Moreover, according to the requirement of the WTO, China had to accept TRIPS, which also meant that the country had to enhance its IPRs policy, because the standards acquired by TRIPS were higher than those of China's IPRs protection. However, whether stronger IPRs protection policy has had positive impact on technology diffusion is still an issue. Therefore, this research explores the impact of IPRs reform on technology diffusion in China.

8.1.2. Purpose of this research

The main purpose of this research is to explore whether stronger IPRs protection gained

from WTO accession can have positive or negative impacts on technology development and diffusion in China. This research concentrates on patent and copyright protection, because these are the most important parts in IPRs protection and they have a direct relationship with technology development and diffusion.

8.1.3. Research processes

In order to accomplish this research, a clear and systematical research process was framed. Theoretical analyses of IPRs protection were basic knowledge, because they could clarify concepts and their characteristics for this research. Thus, this research explored this kind of information first. Arguments about the relation between IPRs protection and technology diffusion were also significant, since these could provide concepts and properties of technology diffusion. Hence, this research reviewed the literature on these arguments. After that, development of IPRs protection in China was investigated, because it could provide the necessary background for this research. Research methodology was then explored. Fieldwork was applied in this research. Semi-structured interviews and self-completion questionnaires were the main parts of this fieldwork. Interviews and questionnaires were accomplished with technological executives of selected Chinese firms. Some official statistics and other sources, such as television programs and interviews with relevant government officials were also collected for comparison with data obtained from the main fieldwork methods. Personal connections were a significant factor for accomplishing this fieldwork. Without recommendation through personal connections, these executives were unwilling to accept interviews and questionnaires. It did not affect the objectivity of fieldwork data, because it only played an introductory role. After finishing the fieldwork, the huge amount of fieldwork data collected from the semi-structured interviews and self-completion questionnaires was analysed. Official statistics and other sources were also analyzed. This research then combined the analytical results from different data and drew fieldwork results. Finally, this research also did a theoretical analysis between the fieldwork results and relevant literature to expose similarities and differences between

this research and other relevant literature.

8.2. Main conclusions of this research

1) During the processes of trying to accede to the WTO and under pressure from the USA, China strengthened its IPRs protection gradually. Most interviewees, except those from the traditional food and the textile sectors, were aware of this change. And most interviewees experienced the change of IPRs protection through their production, except those from the traditional food and the textile sectors.

2) The relation between IPRs protection and technology diffusion had connections with the sensitivities of different industries to IPRs protection. The pharmaceutical, chemical, petroleum, electronic and software sectors had high sensitivities to IPRs protection; the machinery, primary metal and transportation equipment sectors had medium sensitivities to IPRs protection; and the traditional food and the textile sectors had low sensitivities to IPRs protection. Stronger IPRs protection policy had more obvious impacts on sectors with high sensitivities to IPRs protection than sectors with medium and low sensitivities to IPRs protection.

3) The relationship between IPRs protection and technology diffusion in China also had connections with the size and legal status of Chinese firms. Big firms and state-owned firms paid more attention to IPRs protection policy, while the degree of concern to IPRs protection policy of small firms and most private firms was less than that of big and state-owned firms. Therefore, stronger IPRs protection had more significant impacts on big firms and state-owned firms than on small and private firms.

4) Generally, stronger IPRs protection made Chinese firms input more on R&D. It also increased the total number of domestic technologies. Meanwhile, better IPRs protection also promoted some technology transfer from foreign countries to China. However, enforcing stronger IPRs protection encouraged domestic technology development more than technology transfer.

5) Although stronger IPRs protection had positive impacts on technology diffusion, it also had some negative impacts on technology diffusion in China. Better IPRs protection urged most Chinese firms to invest on protecting their technologies from pirating, especially by small firms. It also had a great negative impact on technology diffusion through imitation. Furthermore, stronger IPRs protection provided more power for foreign firms to control their technologies. Most foreign firms increased the prices of their technologies and set up restrictive articles in transferring technologies to Chinese firms based on better protection. Although there were more technologies transferred from foreign countries to China after the country reformed IPRs policy, most of these technologies were basic technologies, whose development depended on further technology transfer from foreign firms. The prices of obtaining technologies from their owners had been increased based on better IPRs protection. Moreover, better IPRs protection also provided power for technology owners to hold their technologies and delay the commercial production of them. This also constrained technology development and diffusion in China.

6) Without better IPRs protection, some technology would still be developed by Chinese firms and transferred from foreign countries to China. Moreover, if imitation occurred, firms with production capability that was difficult to obtain in a short time, could still obtain benefit from developing new technologies. Without better IPRs protection policy, some authors would still publish their works.

7) The relationship between IPRs protection and technology diffusion in China also had connections with other relevant policies, such as the "Open Door" policy, policies that encouraged economic development and R&D, policies that supported some industries and encouraged foreign investment in China and China's big open market. These policies also encouraged technology development and diffusion in China, based on stronger IPRs protection.

8) Because of government propaganda and the fact that there was no other technology protection policy available, most interviewees believed that the current IPRs protection

policy was the best, regardless of some restrictions set up by the current IPRs protection policy.

To conclude, China reinforced its IPRs protection policy while trying to accede to the WTO. Stronger IPRs protection has had both positive and negative impacts on technology diffusion in China. The relationship between IPRs protection reform and technology diffusion in China also related to different industries, the size and legal statuses of firms, and other relevant policies.

8.3. The strength of this research

This research is the first research applying fieldwork to investigate the impact of IPRs protection reform on technology diffusion in China. Although there were many studies that investigated the relationship between IPRs protection and technology development, no research has been done to find out the impact of IPRs reform on technology diffusion in a comparatively comprehensive aspect, which includes domestic technology development and technology transfer from foreign countries in a special country—China. Yang (2003) and Yueh (2009) found that stronger IPRs protection encouraged the use of IPRs protection, especially the use of patents, copyrights and trademarks in China. Meyer (2001) and Awokuse and Yin (2009 and 2010) obtained that better IPRs protection had positive impacts on imports and FDI, which were important channels of transferring technology from foreign countries to China. Bosworth and Yang (2000) also concluded that stronger IPRs protection encouraged technology transfer through licensing in China. Certainly, there were some articles discussing that stronger IPRs did not encourage technology diffusion in some channels in China. Lanoszka (2000) and Yu (2007) concluded that stronger IPRs did not promote FDI, which was an important channel of transferring technology from foreign countries to China. These articles did not investigate the full scale relationship between stronger IPRs protection and technology diffusion. This research explored the full scale relationship between stronger IPRs protection and technology diffusion, including

domestic technology development and technology transfer through important channels such as international trade, FDI, licensing and imitation. Thus, it is the first research about the impact of IPRs protection reform on technology diffusion in China. Moreover, none of those previous researches in China were done through doing fieldwork, including interviews and questionnaires in China. Doing fieldwork was the most important part in this research. Fieldwork including interviews and questionnaires provided fresh and detailed information about the research questions. Fieldwork also provided information in a more intuitional and direct way than results obtained through applying economic models, which made the results of this research easy to understand. The process of doing fieldwork was quite interesting and also helped to obtain many cultural backgrounds and information for this research. Thus, applying fieldwork to investigate the impact of IPRs protection reform on technology diffusion in China is one of the most important contributions of this research. In addition, none of those previous articles involved investigating the relationship between IPRs protection and technology development and diffusion in different specific industries. This research explored the impact of IPRs protection reform on technology diffusion in different specific Chinese industries. This research also explored the impact of IPRs protection reform on technology diffusion in firms with different legal status and sizes in China, which, to date, has not been done by any others. This research also aimed to gather important and unique information about the impact of IPRs protection reform on technology diffusion in China, which cannot be obtained from previous literatures. It found that stronger IPRs protection encouraged more domestic technology development than technology transfer from foreign countries in China. Without a good IPRs policy, Chinese firms with production capability that was difficult to build in a short time could still obtain benefit to cover their cost in doing R&D; and some technology would still be transferred from foreign countries to China because China was a big open market and other favourable policies attracted foreign companies. IPRs protection reform did not have a great influence on technology transfer from foreign countries in the petroleum sector, because petroleum was a very important product for a nation's security and people's livelihood, technologies in this sector was strictly controlled by firms and

governments. This research is also very significant for future IPRs policy decision in China. Currently, few of the policy-makers thought about the disadvantages of the current IPRs protection system. The Chinese government considers stronger IPRs protection to be an advantage, which encourages the government to enforce more strict IPRs protection. This research brings the limitations of the current IPRs protection system to the policy-makers' attention, which might help with their future policy decisions. Finally, this research would be very useful for considering alternative IPRs protection systems. Because the current IPRs protection system also had negative impacts on technology diffusion, it is valuable to think about other alternatives, which may also help the future theoretical development.

8.4. Recommendations for future work

The last part concludes the discussions for this research with some recommendations for the future work.

Firstly, this research only explored the impact of IPRs protection reform on technology diffusion in some main industrial sectors, including the pharmaceutical, chemical, petroleum, electronic, machinery, primary metal, transportation equipment, traditional food, textile, publishing and software sectors. It is valuable to explore the impact of IPRs protection reform on technology diffusion in more industries, because it can help to generalise the characteristics of different industries on the issue of IPRs protection and technology diffusion. This will provide useful information for policy-makers in China.

Secondly, it is also valuable to explore the impact of IPRs protection reform on technology diffusion in other countries, especially other developing countries that have or will reform their IPRs protection. This may be helpful to their further policy decisions.

Thirdly, it is very important and significant to consider other kinds of policy systems of

IPRs protection in the whole world. According to the analyses and discussions in this research, the relation between IPRs protection policy and technology diffusion was different according to different industrial sectors, sizes, legal status of firms, and production capability, as well as other relevant policies. Thus, one standard IPRs protection system cannot be suitable for all kinds of technologies or innovations in different countries. Moreover, according to this research, the current IPRs protection system was not the best system to protect technologies or promote technology diffusion in China, because it also set up some restrictions on technology development and diffusion. Therefore, it is valuable to think about designing a new IPRs protection system to facilitate technology development and diffusion in all kinds of countries, which can accommodate the characteristics of all kinds of technologies and innovations in different conditions.

Appendix 1

Interview guide design

1. Introduce research topic and objectives, the aim of interview, the use of recorder and the promise for keeping anonymous of interviewees.

This part is an introduction to the interview, which can help respondents to understand what will be carried through in the interview and how it will process.

2. Questions related to individual firm

● The characteristics of individual firm

Legal organisation
History
Main areas of activity
Firm size

● Feeling about IPRs protection reform

Whether technological executives feel that China has reformed its IPRs protection?

● The use of IPRs protection, especially patent and copyright during the period of China's reforming IPRs protection.
● The method of obtaining technology in individual firms and its change during China's reformation of its IPRs protection.
● The impact of IPRs protection reform on technology development in an individual firm

Input on R&D
The amount of technology
Cost of technology development
Benefits obtained from technology
The situation of putting technology into commercial production
Restrictions on technology diffusion
What can happen if IPRs protection is unavailable and imitation occurs?

● The impact of IPRs protection reform on technology transfer from foreign countries in individual firm

Channels of technology transfer
The amount of technology transfer
Cost of technology transfer
Restrictions on technology diffusion
What can happen if IPRs protection is unavailable and imitation occurs?

The aim of this part is to find out the influence of IPRs reform on technology diffusion in different firms. Firstly, this part includes background questions, including the characteristics of the individual firm, feelings about the change of IPRs protection policy, the use of IPRs, and the structure of technology. The characteristics of individual firm can be used to divide firms into different categories to check whether the relation between IPRs protection and technology diffusion varies in different kinds of firms. The question about the feeling of the change of IPRs protection and the use of IPRs protection can be used to find out the sensitivity of individual firm to IPRs protection. The question about the method of obtaining technology in individual firm can be used to see whether IPRs reform has impacted on the methods of obtaining technology for different firms. Secondly, this part includes questions about the impact of IPRs reform on technology development in the individual firm. These questions can help to find out the exact influence of IPRs reform on technology development in each firm. Thirdly, this part includes questions about the impact of IPRs reform on technology transfer in the individual firm. These questions can help to find out the detailed influence of IPRs reform on technology transfer by each firm.

3. Questions on the current IPRs protection system

- The impact of the current IPRs protection system on technology diffusion in China
- The advantages and disadvantages of the current IPRs protection system

This part of the questionings can help to understand the opinions of interviewees on whether the current IPRs system is the best system and the advantages and disadvantages of the current IPRs system, based on their experience.

4. Questions about whether other policies can influence the relationship between IPRs protection and technology diffusion in China

- Policies on R&D
- Policies on encouraging a certain industry’s development
- Other relevant policies

This part is helpful for understanding whether other policies in China can influence the relation between IPRs protection and technology diffusion.

5. Say thank you.

Appendix 2

Questionnaire design

Questionnaire Introduction

This questionnaire is part of a study about China's entrance to the WTO, the influence of intellectual property rights (IPRs) protection reform on technology diffusion. The aim of this research is to reveal the impact of IPRs protection reform on technology diffusion in China. This study is predominantly concerned with firms that are involved with technological activities or technology diffusion in China. This questionnaire should be answered by the persons who normally represent the firms when dealing with questions about technology diffusion. But this research also welcomes response from all kinds of persons who wish to give relevant information.

The information collected in this questionnaire provides the researcher with detailed opinion about whether IPRs reform can bring benefit on China's technology diffusion. The information collected through this questionnaire is held confidentially.

The questionnaire will take about 10 to 15 minutes to answer. For any further information, please contact Wei Meng (menggaowei@yahoo.com.cn).

The main part of questionnaire

Q [T1]. Do you normally represent this firm when dealing with questions about technology diffusion?

a. Yes
b. No

Q [T2]. What is the legal status of this firm?

a. Private firm

b. State-owned firm
c. Other (specify) _____
d. Don't know

Q [T3]. How would you best describe your firm's main area of activity?

a. Pharmaceuticals industry
b. Chemicals industry
c. Machinery industry
d. Primary metals industry
e. Electronic industry
f. Transportation equipment industry
g. Traditional food industry
h. Textile industry
i. Software industry
j. Other industry (specify) _____

Q [T4]. Please specify your firm's leading products_____

Q [T5]. Please specify the market share of your firm's leading products in China. _____%

Q [T6]. How many full-time employees and casual staff in total work for your firm?

Full-time employees
a. None
b. 1-19
c. 20-49
d. 50-99
e. 100-199
f. 200-499
g. 500-999
h. 1000-1999
i. 2000 or more
j. Don't know
Casual staff
a. None
b. 1-19
c. 20-49
d. 50-99
e. 100-199
f. 200 or more
g. Don't know

Q [T7]. Does your firm have the right of direct imports and exports?

a. Yes
b. No
C. Don’t know

Q [T8]. How long has your firm been established?

a. 5 years or less
b. 6-9 years
c. 10-19 years
d. 20 years or more
e. Don’t know

Q [T9]. Has your firm held any technology until now?

a. Yes
b. No
c. Don’t know

Q [T10]. If your answer in Q[T9] is Yes, please specify the number of your firms technology._____

Q [T11]. How did your firm normally acquire new technology before China reformed IPRs protection? (Multiple selection)

a. Acquired through own research and development
b. Transferred through domestic trade
c. Transferred through international trade
d. Transferred through foreign direct investment
e. Acquired through domestic licensing
f. Acquired through international licensing
g. Acquired through imitation domestically
h. Acquired through imitation internationally
i. Others (please specify) _____

Q [T12]. Do you think that China’s entrance to the WTO has led to stronger adoption of IPRs protection?

a. Yes
b. No
c. Don’t know

Q [T13]. Has your firm’s main channel to acquire new technology changed since the adoption of stronger IPRs protection?

a. Yes

b. No
c. Don’t know

Q [T14]. If your answer in Q [T13] is Yes, please select the new channels that your firm acquires new technology after the adoption of stronger IPRs protection. (Multiple selection)

a. Acquired through own research and development
b. Transferred through domestic trade
c. Transferred through international trade
d. Transferred through foreign direct investment
e. Acquired through domestic licensing
f. Acquired through international licensing
g. Acquired through imitation domestically
h. Acquired through imitation internationally
i. Others (please specify) _____

Q [T15]. What do you think is the influence of stronger IPRs protection on domestic technology development in China?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don’t know

Q [T16]. What do you think is the influence of stronger IPRs protection on technology transfer from foreign countries in China?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don’t know

Q [T17]. What is the influence of stronger IPRs protection on the development of your firm’s technology?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber

f. Don’t know

Q [T18]. What is the influence of stronger IPRs protection on the commercial production of your firm’s technology?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don’t know

Q [T19]. What is the influence of stronger IPRs protection on your firm’s technology transfer from foreign countries through international trade?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don’t know

Q [T20]. What is the influence of stronger IPRs protection on your firm’s technology transfer from foreign countries through FDI?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don’t know

Q [T21]. What is the influence of stronger IPRs protection on your firm’s technology transfer from foreign countries through licensing?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don’t know

Q [T22]. What is the influence of stronger IPRs protection on your firm’s technology transfer from foreign countries through imitation?

a. Strongly encourage
b. Slightly encourage
c. Neither encourage nor encumber
d. Slightly encumber
e. Strongly encumber
f. Don't know

Q [T23]. How many percentage of your firm's technology cannot be developed without IPRs protection? ___%

Q [T24]. How many percentage of your firm's technology cannot be commercially produced without IPRs protection? ___%

Q [T25]. How many percentage of technology cannot be transferred from foreign countries to your firms without IPRs protection? ___%

Q [T26]. Do you think that the current IPRs protection is the best method to protect and encourage technology development and diffusion?

a. Yes
b. No
c. Don't know

Q [T27]. If your answer in Q [26] is No, please specify the disadvantages of the current IPRs protection.

Q [T28]. If your answer in Q [26] is No, please give some alternative policies that you think can deal with the negative effects caused by the current IPRs protection.

Explanations for questionnaire design

Q [T1] is the question which can help to find out whether the respondent is the desired technological executive. If the respondent is not the desired technological executive, his or her answer may not reflect the true situation about the selective firm. This question is helpful for choosing valid feedback.

Q [T2] and Q [T3] are the questions used to put individual firms into different legal statuses and different industries. These questions can help to make clear whether the relation between IPRs protection policy and technology diffusion is different according to different properties of firms and different industries.

Q [T4], Q [T5], Q [T6] and Q [T7] can help to find out the size of individual firm. These questions are helpful to check whether the relation between IPRs protection and technology diffusion is different according to different size of firms.

Q [T7] has great relation with technology transfer. If the firm has the right of direct imports and exports, it is easy to transfer technology from foreign countries.

Q [T8] tests the history of individual firm. This question can help to find out whether the selected firm has enough history to cover the period before China made stronger IPRs protection. Only if the firm's history is long enough to cover the period before China made stronger IPRs protection, the technological executive of this firm can do comparison between the current situation and former situation about IPRs protection.

Q [T9] and Q [T10] are questions about the technology of selected firms. These questions can help to select which firm has high technological density and check whether technological density has relation with the impact of IPRs protection.

Q [T11], Q [T12], Q [T13] and Q [T14] are questions that used to test whether the selected firm can feel that China has reinforced stronger IPRs protection and whether the methods of getting new technology of selected firm has changed since China made stronger IPRs protection. These questions are very helpful to check the sensitivity to IPRs protection policy of selected firm.

Q [T15] and Q [T16] test the general opinions of selected technological executives about the impact of stronger IPRs protection on domestic technology development and technology transfer in China.

Q [T17], Q [T18], Q [T19], Q [T20], Q [T21] and Q [T22] are questions that applied to find out selected technological executives' opinions about the impact of stronger IPRs protection on technology development by their firms and technology transfer through different channels for their firms.

Q [T23], Q [T24] and Q [T25] are used to let selected technological executives to forecast what will happen if there is not IPRs protection available.

Q [T26], Q [T27], and Q [T28] are questions that applied to find out the advantages and disadvantages of the current IPRs protection on technology diffusion in China as well as the methods that can deal with the weaknesses of the current IPRs protection.

Appendix 3

Fieldwork summary

Doing fieldwork in China was the most important and interesting part of this research. This section summarizes the process and significant factors of doing fieldwork in China in this research.

I entered the field in China in May of 2007. It was intended to finish the pilot job by the end of May, because I only planned to do two pilots for each of interview and questionnaire and I thought it was easy to obtain these pilots. However, when I tried to contact the selected interviewees, I was very disappointed with the results. No one wanted to accept the pilot interviews, although I had tried my best. By the end of May 2007, no pilot jobs were finished. In the beginning of June 2007, I sent out the original questionnaires to some selected firms. However, only one partially completed response for the pilot questionnaires was received by the end of June, although I sent out them for the second time in the middle of June. This result pushed me to do use personal connections to contact technological executives in selected industries for pilot interviews and face-to-face pilot questionnaires. Although the pilot job was accomplished with some incomplete aspects, the pilot job was very useful for revising the interview guide and the original questionnaire. After finishing the pilot job, I reflected on the reasons for the reluctance of technological executive in Chinese firms to accept interviews or fill in questionnaires. The reasons came from two factors. Firstly, the Chinese government did not have a systematic framework for making policies and obtaining feedback on policy implementation from individuals. Thus, there was little published research giving feedback from individuals about the policies of Chinese government. Chinese people and firms seldom received this kind of investigation, which means that Chinese people and firms were not familiar with and were reluctant to

participate in this kind of research and investigation. Secondly, the atmosphere in Chinese society on doing research and investigation was not as good as that in advanced society, which left the Chinese people and firms without an interest in research and investigation. Chinese firms just wanted to develop their productive capability and create more profit. They had not arranged spare time or energy to embark on research or investigation, especially researches for providing suggestions or feedback for policies put forward by the government. Because of these two factors, technological executives of Chinese firms did not want to give interviews or complete questionnaires.

As I am Chinese, I know that personal connections are very important in China. However, I did not realize that personal connections are so important that they are indispensable for doing anything in China. Chinese people try to develop their personal connections every day and they are also good at using them. In China, using personal connections are quite normal. Without knowing this, the fieldwork faced many difficulties in the early stages. However, having sensed the importance of personal connections and using them in the fieldwork allowed it to progress smoothly in the later period. Thus, in each of the selected sectors, I used personal connections to introduce myself to one technological executive and then let the executive to introduce me to other firms in each sector. I used personal connections from my classmates, my friends, and even the friends of my parents and my relatives. This method helped me to accomplish my interviews.

Entering each Chinese firm to do interviews and face-to-face questionnaires also brought some important information about this research. I could feel the strict management of each Chinese firm, especially the strict control of their technologies and plants. I could not be permitted to enter the plant before some managers confirmed my status. I also needed to leave my personal information in the reception of almost all firms. Some departments and rooms of some firms were locked and had notices prohibiting entry by visitors and any photography. Moreover, because this research involved some issues of technological development in individual firms, some executives

emphasized that it was absolutely not permitted to make recordings of the interviews.

After entering each firm and meeting a technological executive, I began with conversation. Some interviewees talked very little. I had to try to probe more explanations from them and pay more attention to keep friendly atmosphere to make the interview goes well. However, there were some other cases, which I found more difficult to control. Some interviewees talked a lot during the interview. Moreover, some interviewees quickly strayed from the point. I had to draw them back without letting them feel that I was impolite or un friendly. This was more difficult than trying to probe their responses, because the limits of proper courtesy were uncertain and sometimes I had to keep talking with the interviewees about irrelevant matters for quite long time. This also increased the difficulties in picking out the important information from the interview records.

The information obtained from interviews showed that many interviewees knew that China implemented stronger IPRs protection when it tried to accede to the WTO. China's entry to the WTO was a very important issue for the Chinese people similar to Beijing becoming the host city for the 2008 Olympic Games. Most Chinese people cared about whether China would be accepted by the WTO while China negotiated with other WTO members. China's entrance to the WTO brought many different impacts in China; IPRs protection reform is one of the most important. Many Chinese newspapers and websites reported the IPRs requirements put forward by WTO members, especially by the USA and the reform process of IPRs protection in China. In China, the executive of a state-owned firm works for the government, and is just like a government official receiving similar treatment. Thus, grasping relevant policies is particularly important for managers and executives in state-owned Chinese firms. Thus, most executives in state-owned firms know the change of IPRs protection well in China. Executives of private firms also started to pay more attention to the change of Chinese policies in order to make the policies better serve the development of their firms. Moreover, because IPRs protection also has a direct relation with the operation of Chinese firms,

different local governments also trained executives of Chinese firms in their regions. Thus, more and more executives pay attention to relevant policy changes, including IPRs protection reform in China.

Another significant finding obtained from the interviews and questionnaires was that almost all executives in Chinese firms consider that current IPRs protection is the best method for protecting technology and promoting technology diffusion. One possible reason is that there is no other policy available for protecting technology in China. Another possible reason is that Chinese people just accept the policies issued by the government without questioning their problems or limitations. This is a kind of Chinese tradition. Chinese people always believe that the right of government is superior to the rights of individual persons. Sometimes, Chinese people prefer to scarify personal interests to realize the state's interests. Usually, Chinese people do not ask questions about policies issued by the government, but just believe that these policies are very good. Thus, most Chinese people do not pay attention to the disadvantages of China's policies. This came out clearly in the interviews in this research. Many executives mentioned some points of the limitations of the current IPRs protection on technology diffusion in China, but without realizing that they had done so. Base on these two reasons, the current IPRs protection policy was considered by many executives to be the best policy to encourage technology development and diffusion.

Appendix 4

Fieldwork process

May 2007

16: Entered the field in China

18: Went to the first selected Chinese chemical firm to do a pilot interview in Beijing. The researcher was not permitted to enter the firm.

21: Went to the second selected Chinese chemical firm to do a pilot interview in Beijing. The researcher was not permitted to enter the firm.

23: Went to the third selected Chinese chemical firm to do a pilot interview in Beijing. The researcher was not permitted to interview the selected technological executive.

28: Went to the fourth selected Chinese pharmaceutical firm to do a pilot interview in Beijing. The researcher was not permitted to interview the selected technological executive again.

29: Went to the fifth selected Chinese pharmaceutical firm to do a pilot interview in Beijing. The researcher was not permitted to interview the selected technological executive. The lady in the reception office gave the researcher the office line number of a member of the staff in the firm and let the researcher contact him in advance to make sure that he could accept the interview. The researcher called as advised, but no one answered the phone that time.

30: The researcher called designated person in the fifth Chinese pharmaceutical firm. A lady answered the phone and told the researcher that the person was on business trip and would back in the next week.

June 2007

1: Transferred the original designed questionnaires into Chinese and website versions.

4: Sent out the original designed questionnaires to six selected Chinese firms, which in the pharmaceutical and chemical sectors. The researcher waited for 10 days to get the

feedback from the technological executives in the selected Chinese firms.

5: Went to the sixth selected Chinese pharmaceutical firm to do pilot a interview in Shijiazhuang. The researcher was not permitted to interview the selected technological executive.

7: Went back to Beijing and contacted the staff member in the fifth selected Chinese pharmaceutical firm. The man answered the phone, but he did not want to do the interview. He said he did not have the time to do it and that accepting interview was very important and his manager would not allow him to accept the interview.

8: Tried to contact friends to use personal connections for introductions to selected Chinese firms for pilot interviews.

13: There was no response to the questionnaires. The researcher had written a detailed introduction and explanation of the original designed questionnaires.

14: Sent out the original questionnaires together with the detailed introduction and explanation to selected six Chinese firms, which are in the pharmaceutical and chemical sectors. The researcher planned to wait for another 10 days for responses from the technological executives in selected Chinese firms.

15: Did the first pilot interview with a Chinese chemical firm in Beijing.

19: Did the second pilot interview with a pharmaceutical firm in Shijiazhuang.

20-23: Analysed these two pilot interviews and revised the original interview guide.

25: Only one partially completed questionnaire was received. The researcher felt very disappointed about it.

26: Contacted friends to use personal connections to introduce me for pilot questionnaires in order to test the original designed questionnaires.

28: Did the first pilot face-to-face questionnaire with a Chinese pharmaceutical firm in Tangshan.

29: Did the first pilot face-to-face questionnaire with a Chinese chemical firm in Beijing.

30: Analysed the pilot questionnaires and revised the original questionnaire.

July 2007

1-2: Analysed the pilot questionnaires and revised the original questionnaire.

4: Did the first interview with a Chinese chemical firm in Beijing.

6: Did the second interview with a Chinese pharmaceutical firm in Beijing.

7-9: Revised the original questionnaire and sent the revised questionnaire to all selected Chinese firms. The researcher planed to wait for 10 days to get responses.

11: Did the third interview with a Chinese pharmaceutical firm in Tianjin.

14: Did the fourth interview with a Chinese transportation equipment firm in Shenyang.

16: Did the fifth interview with a Chinese textile firm in Shenyang.

18: 14 useful responses to the internet questionnaires were received.

19: Did the sixth interview with a Chinese pharmaceutical firm in Tangshan.

20: Did the seventh interview with a Chinese chemical firm in Tangshan.

23: Did the eighth interview with a Chinese textile firm in Tangshan.

25: Did the ninth interview with a Chinese textile firm in Tangshan.

26: Did the 10th interview with a Chinese transportation equipment firm in Tangshan.

27: Did the 11th interview with a Chinese electronic firm in Tangshan.

28: 3 more useful responses to the internet questionnaires were received. Sent out the questionnaire to all selected Chinese firms for the second time. The researcher planed to wait for 10 days for responses.

31: Did the 12th interview with a Chinese petroleum firm in Beijing.

August 2007

2: Did the 13th interview with a Chinese petroleum firm in Beijing.

3: Interviewed two government officials in Beijing.

6: Interviewed a manager at a publishing firm in Beijing, but did not get enough good information from him. He helped me to contact government officials who worked for the departments that are in charge of the publishing sector in Beijing.

8: Did the 14th and 15th interviews with government officials who worked for the departments in charge of publishing sector in Beijing.

9: 12 more useful responses to the internet questionnaires were received.

10: Did the 16th interview with a Chinese machinery firm in Beijing.

13: Did the 17th interview with a Chinese software firm in Beijing.

15: Did the 18th interview with a Chinese software firm in Beijing.

16: Did the 19th and 20th interviews with two Chinese primary metals firms in Tangshan.

17: Did the 21st interview with a Chinese primary metals firm in Tangshan.

18: Did the 22nd interview with a Chinese software firm in Tangshan. Did the 23rd interview with a Chinese chemical firm in Tangshan.

19: Did the 24th interview with a Chinese chemical firm in Tangshan. Did the 25th interview with a Chinese machinery firm in Tangshan. Did the 26th interview with a Chinese traditional firm in Tangshan.

24: Did the 27th telephone interview with a Chinese petroleum firm in Beijing. 6 more useful responses to the internet questionnaires were received.

25: Did the 28th telephone interview with a Chinese electronic firm in Beijing.

27: Did the 29th and 30th interviews with two Chinese traditional food firms in Tangshan. One more useful response to the internet questionnaire was received. The researcher decided to do face-to-face questionnaires to get enough feedback.

28: Did the 31st interview with a Chinese textile firm in Tangshan. Did 2 questionnaires with Chinese software firms in Tangshan.

29: Did the 32nd interview with a Chinese machinery firm in Tangshan. Did the 33rd interview with a Chinese traditional food firm in Tangshan.

30: Did the 34th interview with a Chinese primary metals firm in Qinhuangdao.

31: Did the 35th interview with a Chinese electronic firm in Beijing. Visited a government official working in the Statistics Bureau of China and obtained some official statistics.

September 2007

3: Did the 36th interview with a Chinese machinery firm in Tianjin. Did the 37th interview with a Chinese transportation equipment firm in Tianjin.

4: Did 1 questionnaire with a Chinese software firm in Tianjin. Did 3 questionnaires with Chinese textile firms in Tianjin.

5: Did 3 questionnaires with Chinese traditional food firms in Tianjin.

6: Did 2 questionnaires with Chinese machinery firms in Tianjin. Did 2 questionnaires with a Chinese transportation equipment firms in Tianjin.

7: Did 2 questionnaires with Chinese pharmaceutical firms in Tianjin. Did 2

questionnaires with Chinese chemical firms in Tianjin.

8: Did 1 questionnaire with a Chinese electronic firm in Tianjin.

11: Did the 38th interview with a Chinese textile firm in Shijiazhuang. Did 3 questionnaires with Chinese pharmaceutical firms in Shijiazhuang.

12: Did 1 questionnaire with a Chinese electronic firm in Shijiazhuang.

13: Did 1 questionnaire with a Chinese machinery firm in Shijiazhuang.

14: Did 2 questionnaires with Chinese machinery firms in Shijiazhuang.

17: Did 2 questionnaires with Chinese chemical firms in Shijiazhuang.

19: Did 3 questionnaires with Chinese textile firms in Shijiazhuang.

20: Did 1 questionnaire with a Chinese traditional food firm in Shijiazhuang.

24: Did 2 questionnaires with Chinese pharmaceutical firms in Tangshan.

26: Did 2 questionnaires with Chinese electronic firms in Tangshan.

27: Did 2 questionnaires with Chinese chemical firms in Tangshan.

28: Did 1 questionnaire with a Chinese chemical firm in Tangshan.

October 2007

8: Did 1 questionnaire with a Chinese chemical firm in Qinhuangdao.

9: Did 2 questionnaires with Chinese chemical firms in Qinhuangdao.

11: Did 2 questionnaires with Chinese traditional food firms in Qinhuangdao.

12: Did 2 questionnaires with Chinese primary metals firms in Qinhuangdao.

13: Did 1 questionnaire with a Chinese machinery firm in Qinhuangdao.

16: Did 1 questionnaire with a Chinese electronic firm in Tangshan.

18: Did 1 questionnaire with a Chinese machinery firm in Shenyang.

19: Did 1 questionnaire with a Chinese textile firm in Shenyang.

20: Did 1 questionnaire with a Chinese textile firm in Shenyang. Did 1 questionnaire with a Chinese transportation equipment firm in Shenyang.

23: Did 1 questionnaire with a Chinese traditional food firm in Shenyang.

24: Did 1 questionnaire with a Chinese primary metals firm in Shenyang.

25: Did 2 questionnaires with Chinese primary metals firms in Jinzhou.

29: Did 2 questionnaires with Chinese machinery firms in Tangshan.

30: Did 2 questionnaires with Chinese transportation equipment firms in Tangshan.

November 2007

2: Did 2 questionnaires with Chinese primary metals firms in Handan.

5: Did 1 questionnaire with a Chinese transportation equipment firm in Handan.

6: Did 1 questionnaire with a Chinese traditional food firm in Handan.

9: Did 1 questionnaire with a Chinese primary metals firm in Tangshan.

14: Did 1 questionnaire with a Chinese primary metals firm in Beijing.

16: Did 1 questionnaire with a Chinese traditional food firm in Beijing.

20: Did 1 questionnaire with a Chinese traditional food firm in Tangshan.

22: Did 1 questionnaire with a Chinese textile firm in Tangshan.

26: Did 1 questionnaire with a Chinese textile firm in Tangshan.

December 2007

5: Did 1 questionnaire with a Chinese primary metals firm in Xuanhua.

12: Did 1 questionnaire with a Chinese transportation equipment firm in Beijing.

18: Did 1 questionnaire with a Chinese traditional food firm in Tangshan.

Appendix 5

Interviews list

No.	Date	Industries	Size	Location
1	4 July 2007	chemical	big	Beijing
2	6 July 2007	pharmaceutical	big	Beijing
3	11 July 2007	pharmaceutical	medium	Tianjin
4	14 July 2007	transportation equipment	big	Shenyang
5	16 July 2007	Textile	small	Shenyang
6	19 July 2007	pharmaceutical	small	Tangshan
7	20 July 2007	chemical	small	Tangshan
8	23 July 2007	Textile	small	Tangshan
9	25 July 2007	Textile	small	Tangshan
10	26 July 2007	transportation equipment	big	Tangshan
11	27 July 2007	Electronic	small	Tangshan
12	31 July 2007	Petroleum	big	Beijing
13	2 August 2007	Petroleum	big	Beijing
14	8 August 2007	publishing		Beijing
15	8 August 2007	publishing		Beijing
16	10 August 2007	Machinery	big	Beijing
17	13 August 2007	Software	medium	Beijing
18	15 August 2007	Software	big	Beijing
19	16 August 2007	primary metals	small	Tangshan
20	16 August 2007	primary metals	small	Tangshan
21	17 August 2007	primary metals	big	Tangshan
22	18 August 2007	Software	small	Tangshan
23	18 August 2007	chemical	small	Tangshan
24	19 August 2007	chemical	medium	Tangshan
25	19 August 2007	Machinery	small	Tangshan
26	19 August 2007	traditional food	small	Tangshan
27	24 August 2007	Petroleum	big	telephone interview
28	25 August 2007	Electronic	big	telephone interview
29	27 August 2007	traditional food	small	Tangshan
30	27 August 2007	traditional food	small	Tangshan
31	28 August 2007	Textile	small	Tangshan
32	29 August 2007	Machinery	small	Tangshan
33	29 August 2007	traditional food	small	Tangshan

continued

No.	Date	Industries	Size	Location
34	30 August 2007	primary metals	big	Qinhuangdao
35	31 August 2007	Electronic	small	Beijing
36	3 September 2007	Machinery	medium	Tianjin
37	3 September 2007	transportation equipment	small	Tianjin
38	11 September 2007	Textile	small	Shijiazhuang

Size classification:

Big: The number of full-time employees is more than 2000 (including 2000) or the market share of the firm's leading products in China is more than 10% (including 10%).

Medium: The number of full-time employees is more than 200 (including 200) but less than 2000 (not including 2000) and the market share of the firm's leading products in China is more than 0.5% (including 0.5%) but less than 10% (not including 10%).

Small: The number of full-time employees is less than 200 (not including 200) or the market share of the firm's leading products in China is less than 0.5% (not including 0.5%).

Appendix 6

Questionnaires list

List of abbreviations

A: Alkali
AL: Aluminum
AP: aluminum polychloride
BE: bicycle equipment
C: Chemicals
CE: car equipment
CEF: computer electronic fitting
CFP: cooked farm produce
CM: cooked meat
CM1: centrifugal machine
CM2: chemical machine
CM3: cement machine
CM4: ceramic machine
CP: chemical paper
CW: R&D cooperating with research institutes
C1: Cake
C2: Chestnut
EBE: electric bicycle equipment
EF: electronic fitting
EM: engine machine
FC1: fine chemicals
FC2: fireproof chemicals
FEF: fridge electronic fitting
GCM: gear change machine
IM: irrigation machine
L: Lathe
LE: lorry equipment
M: Medicine
MM: metallurgy machine
O: Ore
P: Petrochemicals
PCE: plane, car equipment
PSEF: power supply electronic fitting

QEF: quartz electronic fitting
S: Steel
SE: supervision equipment
SEF: speaker electronic fitting
ST: sharing technology with other state-owned firms
SW: Software
T: Textile
TEF: television electronic fitting
TE1: train equipment
TE2: tricycle equipment
TF: traditional food
TH: traditional handiwork
WP: wait for patented technology to be overdue

Content

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
1	07/18	a	b	i	SW	40	ga	a	c	a	6	ah	a	a	af	a	a	a	a	b	b	a	e	50	20	10	a		
2	07/18	a	b	i	SW	30	ga	a	c	a	14	ah	a	a	a	a	b	a	b	b	b	b	e	40	20	0	a		
3	07/18	a	b	e	TEF	12	ie	a	c	a	268	acfh	a	a	aef, CW	a	a	a	b	a	b	a	e	50	20	20	a		
4	07/18	a	b	e	TEF	12	if	a	c	a	360	afh	a	a	acf	a	a	a	a	a	b	a	e	30	20	20	a		
5	07/18	a	a	e	SE	0.07	fa	a	c	a	60	bgh	a	a	abcef	a	b	a	b	a	b	a	e	50	10	10	a		
6	07/18	a	b	f	PCE	10	if	a	d	a	120	acfh, ST	a	a	acdef, CW	a	a	a	b	a	a	a	e	30	10	20	a		
7	07/18	a	b	f	BE	0.3	he	a	c	a	11	bgh	a	a	abc, CW	a	a	a	b	a	c	c	e	20	10	10	a		
8	07/18	a	b	f	EBE	0.2	he	a	c	a	10	bghc	a	a	aef, CW	a	a	a	c	c	c	b	e	20	0	10	a		
9	07/18	a	b	a	M	0.5	hc	a	b	a	14	ah, ST	a	a	acdef, CW, WP	a	a	a	b	a	a	a	e	40	10	20	a		
10	07/18	a	b	a	M	1	ha	a	b	a	8	ah, ST	a	a	acdef, CW, WP	a	b	a	b	a	a	a	e	50	10	30	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
11	07/18	a	b	a	M	12	if	a	d	a	68	Afh, ST	a	a	acdef, CW	a	a	a	a	a	a	a	e	50	20	20	a		
12	07/18	a	b	c	EM	20	if	a	d	a	25	cegh	a	a	aef	a	a	a	b	a	a	a	e	30	0	10	a		
13	07/18	a	b	c	CM3	5	gc	a	c	a	3	bcgh	a	a	abce	a	b	a	c	b	c	b	e	20	0	10	a		
14	07/18	a	a	c	MM	0.1	fa	b	b	b	0	g	c	b		a	f	c	c	c	c	c	d	0	0	0	a		
15	07/28	a	a	b	C	5	ga	a	c	a	12	agh	a	a	acdef, CW	a	a	a	b	a	b	a	e	60	10	30	a		
16	07/28	a	b	g	C1	0.01	fb	b	b	b	0	secret recipe	a	b		a	f	c	c	c	c	c	c	0	0	0	a		
17	07/28	a	a	i	SW	0.1	fa	a	b	a	1	gh	a	a	agh	a	b	a	a	b	b	b	e	10	10	0	a		
18	08/09	a	b	b	A	12	if	a	c	a	10	cfh	a	a	aef, CW	a	c	a	a	b	c	b	e	80	10	30	a		
19	08/09	a	b	a	M	11	ie	a	d	a	68	afh, ST	a	a	acdef, CW	a	a	a	b	a	a	a	e	30	20	20	a		
20	08/09	a	b	d	S	5	if	a	d	a	34	ach	a	a	acef, CW	a	a	a	a	b	c	a	e	20	10	10	a		
21	08/09	a	b	e	FEF	20	ie	a	c	a	4867	acgh	a	a	abc, CW	a	b	a	c	b	c	a	e	50	20	20	a		
22	08/09	a	b	e	TEF	20	if	a	c	a	909	cfgh	a	a	abcef	a	b	a	c	a	c	a	e	50	20	20	a		
23	08/09	a	b	i	SW	15	ga	a	c	a	10	ah	a	a	af	a	a	a	a	c	c	a	e	40	10	10	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
24	08/09	a	b	i	SW	5	ga	a	c	a	6	bch	a	a	abc	a	b	a	a	a	b	b	e	30	10	10	a		
25	08/09	a	b	f	CE	8	if	a	c	a	11	ach	a	a	abcdf, CW	a	a	a	c	b	a	b	e	30	0	10	a		
26	08/09	a	b	f	CE	8	if	a	c	a	66	ch	a	a	adf	a	a	a	c	a	a	a	e	20	0	20	a		
27	08/09	a	b	b	P	30	if	a	b	a	43	acfh	a	a	acef, CW	a	c	b	c	a	b	a	e	60	20	20	a		
28	08/09	a	b	d	AL	3	if	a	d	a	24	abcg	a	a	abd, CW	a	b	a	b	b	a	a	e	20	10	20	a		
29	08/09	a	b	i	SW	3	fa	a	c	a	4	bg	a	a	abc	a	a	a	b	a	a	b	e	20	10	10	a		
30	08/24	a	b	a	M	10	he	a	c	a	34	ah, ST	a	a	acdef, CW	a	a	a	b	a	a	a	e	50	20	20	a		
31	08/24	a	b	b	C	10	if	a	d	a	24	afh	a	a	abef, CW	a	a	a	a	b	c	a	e	80	10	30	a		
32	08/24	a	b	e	EF	18	if	a	c	a	1436	cfh	a	a	adef	a	a	a	b	a	a	a	e	40	10	20	a		
33	08/24	a	b	i	SW	10	fa	a	c	a	9	ag	a	a	a	a	a	a	a	c	c	b	e	50	10	0	a		
34	08/24	a	a	i	SW	3	fa	a	b	a	3	ch	a	a	abf	a	b	a	b	b	c	a	e	30	10	20	a		
35	08/24	a	a	i	SW	6	fa	a	c	a	3	bcgh	a	a	a	a	a	a	b	c	c	c	e	30	20	0	a		
36	08/27	a	a	e	CEF	10	if	a	d	a	156	acfh	a	a	abcd, CW	a	a	a	a	a	a	a	e	50	10	30	a		
37	08/28	a	a	i	SW	0.1	ea	a	b	a	2	gh	a	a	agh	a	b	a	b	c	c	b	e	20	0	0	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
38	08/28	a	a	i	SW	0.1	ea	a	b	a	1	gh	a	a	a	a	b	a	c	c	c	c	e	20	0	0	a		
39	09/03	a	a	i	SW	0.1	ea	b	b	a	1	gh	a	a	a	a	c	b	c	c	c	c	e	10	10	0	a		
40	09/04	a	b	h	T	0.01	ha	a	d	b	0	TH	a	b		a	a	c	c	c	c	c	c	0	0	0	a		
41	09/04	a	b	h	T	0.1	ga	a	d	b	0	TH	a	b		b	a	c	c	c	c	c	c	0	0	0	a		
42	09/04	a	b	h	T	0.01	ha	a	c	b	0	TH	c	b		a	a	c	c	c	c	c	c	0	0	0	a		
43	09/05	a	b	g	C1	0.01	eb	b	c	a	1	secret recipe	a	b		b	f	c	c	c	c	c	c	0	0	0	a		
44	09/05	a	b	g	C1	0.01	ec	b	c	b	0	secret recipe	c	b		f	f	c	c	c	c	c	c	0	0	0	a		
45	09/05	a	b	g	CM	0.01	fa	b	c	b	0	secret recipe	c	b		f	f	c	c	c	c	c	c	0	0	0	a		
46	09/06	a	a	c	CM4	3	ga	a	b	a	2	bg	a	a	aceg	a	b	b	c	b	c	c	e	20	0	0	a		
47	09/06	a	b	c	MM	2	hd	a	c	a	2	bch	a	a	abce	a	a	a	c	c	b	b	e	20	0	10	a		
48	09/06	a	b	f	LE	20	if	a	d	a	12	cfh	a	a	acf, CW	a	a	a	c	b	a	b	e	50	0	10	a		
49	09/06	a	a	f	TE2	0.2	ha	b	b	b	0	bcgh	c	b		b	c	c	c	c	c	c	c	0	0	0	a		
50	09/07	a	a	a	M	0.1	fa	a	b	a	21	gh	a	a	hgf, CW	a	b	b	c	c	c	c	e	30	0	0	a		
51	09/07	a	a	a	M	0.1	fa	a	c	a	4	gh	a	a	gh, CW	a	c	b	c	c	c	b	e	20	10	0	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
52	09/07	a	b	b	CP	5	hd	a	b	a	15	ag	a	a	abc, CW	a	b	a	c	c	c	c	e	60	20	20	a		
53	09/07	a	a	b	FC1	7	ga	a	c	a	3	aeg	a	a	aef, CW	a	b	a	c	a	c	b	e	50	10	20	a		
54	09/08	a	a	e	EF	0.05	fa	b	b	a	56	bcgh	a	a	abc	a	a	a	c	b	b	b	e	50	15	20	a		
55	09/11	a	b	a	M	10	ie	a	b	a	27	ah, ST	a	a	acdef, WP	a	a	a	a	a	a	a	e	50	20	20	a		
56	09/11	a	a	a	M	0.5	hd	a	b	a	10	egh	a	a	ef, CW, WP	a	b	a	c	c	c	a	e	50	10	10	a		
57	09/11	a	a	a	M	0.5	hc	a	c	a	10	gh	a	a	aef, CW, WP	a	b	a	c	c	c	a	e	50	15	20	a		
58	09/12	a	a	e	QEF	0.1	fa	b	c	a	5	bcg	a	a	abef	a	a	a	c	b	b	a	e	30	0	0	a		
59	09/13	a	a	c	CM4	0.1	fa	b	c	b	0	g	c	b		b	b	b	f	c	f	c	d	0	0	0	a		
60	09/14	a	b	c	GCM	5	hd	a	c	a	1	beg	a	a	abce	a	b	a	c	c	c	b	e	30	0	0	a		
61	09/14	a	a	c	L	0.01	fa	b	b	b	0	g	a	b		a	f	c	c	c	c	f	c	0	0	0	c		
62	09/17	a	b	b	FC1	15	if	a	c	a	8	ech	a	a	acf, CW	a	c	b	b	b	c	b	e	50	0	50	a		
63	09/17	a	a	b	FC2	0.1	ea	a	b	a	1	bgh	a	a	abc	a	b	a	c	b	c	c	e	50	0	30	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
64	09/19	a	b	h	T	0.1	ha	b	c	b	0	TH	a	b		a	f	f	c	c	c	c	c	0	0	0	a		
65	09/19	a	a	h	T	0.1	ha	b	c	b	0	TH	c	b		f	f	f	c	c	c	c	c	0	0	0	a		
66	09/19	a	a	h	T	0.1	ga	b	c	b	0	TH	a	b		f	f	c	c	c	c	c	c	0	0	0	a		
67	09/20	a	a	g	C1	0.01	fa	b	b	b	0	secret recipe	c	b		f	f	c	c	c	c	c	c	0	0	0	a		
68	09/24	a	a	a	M	0.1	fa	a	b	a	4	gh	a	a	hg, CW, WP	a	c	a	b	c	c	b	e	20	10	10	a		
69	09/24	a	a	a	M	Less Than 0.1	fa	b	c	a	7	gh	a	a	g, CW, WP	a	b	b	c	b	c	b	e	20	10	10	a		
70	09/26	a	a	e	EF	0.1	ea	b	b	b	0	beh	a	b		a	b	a	c	c	c	c	d	20	10	0	a		
71	09/26	a	a	e	PSEF	0.1	ea	b	c	b	0	bcgh	a	b		a	b	a	b	c	c	c	d	20	10	10	a		
72	09/27	a	a	b	AP	0.1	fa	a	c	a	3	egh	a	b		b	b	b	c	c	c	c	e	10	0	20	a		
73	09/27	a	a	b	FC2	0.1	ea	a	b	a	3	g	a	b		c	b	b	c	c	c	c	e	20	10	10	a		
74	09/28	a	a	b	C	around 3	ga	a	c	a	7	acgh	a	a	ae, CW	a	a	a	b	b	b	c	e	50	0	20	a		
75	10/08	a	a	b	CP	0.1	ea	b	b	a	2	bg	a	a	abce	a	a	a	c	b	c	b	e	50	20	10	a		
76	10/09	a	a	h	T	0.1	ga	b	b	b	0	TH	a	b		f	f	c	c	c	c	c	c	0	0	0	a		
77	10/09	a	a	h	T	0.1	ga	b	b	b	0	TH	c	b		f	f	f	c	c	c	c	c	0	0	0	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
78	10/11	a	a	g	C1	0.01	ea	b	c	a	2	secret recipe	c	b		f	f	c	c	c	c	c	c	0	0	0	a		
79	10/11	a	a	g	C2	0.01	ea	b	c	a	1	secret recipe	a	b		a	f	c	c	c	c	c	c	0	0	0	a		
80	10/12	a	a	d	S	0.01	ha	a	b	a	2	bcgh	a	a	abch	a	a	a	b	b	c	b	e	20	0	10	a		
81	10/12	a	a	d	S	0.1	ga	b	c	b	0	bg	a	b		b	b	b	b	c	c	c	d	10	0	0	c		
82	10/13	a	a	c	IM	0.1	fa	b	c	b	0	g	a	b		a	f	c	f	c	c	c	d	0	0	0	c		
83	10/16	a	b	e	SEF	0.09	fc	a	c	a	42	bcfh	a	a	abcf	a	a	a	b	a	b	a	e	20	10	10	a		
84	10/18	a	b	c	CM1	16	ihd	a	b	a	9	ceh	a	a	ace	a	a	a	c	b	b	a	e	30	10	20	a		
85	10/19	a	a	h	T	0.01	fa	a	c	b	0	TH	a	b		f	f	c	c	c	c	c	c	0	0	0	a		
86	10/20	a	a	h	T	0.01	fa	b	c	b	0	TH	c	b		a	f	c	c	c	c	c	c	0	0	0	a		
87	10/20	a	b	f	CE	10	if	a	d	a	14	ch	a	a	adf	a	a	a	b	a	a	b	e	20	10	10	a		
88	10/23	a	a	g	C1	0.01	fa	b	c	b	0	secret recipe	a	b		b	f	c	c	c	c	c	c	0	0	0	a		
89	10/24	a	a	d	O	0.01	ha	b	b	b	0	bg	c	b		b	c	c	c	c	c	c	c	0	0	0	c		
90	10/025	a	a	d	O	0.01	ga	b	b	b	0	bcg	c	b		b	c	c	c	c	c	c	d	0	0	0	c		
91	10/25	a	a	d	AL	0.01	ha	a	c	a	5	bcgh	a	a	abc, CW	a	b	a	b	b	c	b	e	20	0	10	a		
92	10/29	a	b	c	MM	10	ie	a	d	a	9	bcgh	a	A															

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
93	10/29	a	b	c	CM2	10	ihe	a	d	a	5	bch	a	a	ac	a	a	a	b	a	c	a	e	30	0	10	a		
94	10/30	a	b	f	TE1	6	if	a	d	a	10	ach, ST	a	a	adf, CW	a	a	a	c	a	a	a	e	30	10	20	a		
95	10/30	a	a	f	TE2	0.1	ha	b	b	b	0	gh	c	b		c	c	c	c	c	c	c	c	0	0	0	a		
96	11/02	a	b	d	S	10	if	a	c	a	29	bch	a	a	acf, CW	a	b	a	c	a	c	b	e	30	0	0	a		
97	11/02	a	b	d	S	0.01	ha	b	b	a	3	bcgh	a	a	abc, CW	a	b	a	a	a	c	c	e	30	0	10	a		
98	11/05	a	b	f	EBE	0.1	ha	a	c	a	6	bch	a	a	abc	a	b	a	b	b	c	c	d	10	5	10	a		
99	11/06	a	a	g	CFP	0.01	ea	b	b	a	1	secret recipe	c	b		a	f	c	c	c	c	c	c	0	0	0	a		
100	11/09	a	b	d	AL	3	if	a	d	a	18	ach	a	a	acf, CW	b	a	a	c	a	c	b	e	20	0	20	a		
101	11/14	a	b	d	S	2	if	a	c	a	12	afg	a	a	aef, CW	b	a	a	a	c	b	c	e	30	10	0	a		
102	11/16	a	a	g	TF	0.01	ea	b	c	b	0	secret recipe	c	b		b	f	c	c	c	c	c	c	0	0	0	a		
103	11/20	a	a	g	CM	0.01	fa	b	c	a	1	secret recipe	c	b		b	f	c	c	c	c	c	c	0	0	0	a		
104	11/22	a	b	h	T	0.1	ga	b	b	b	0	TH	a	b		f	f	c	c	c	c	c	c	0	0	0	a		

Content (continued)

No.	Date (2007)	Answer (T1-T28)																										
		1	2	3	4	5 (%)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23 (%)	24 (%)	25 (%)	26	27	28
105	11/26	a	b	h	T	0.01	ga	b	c	b	0	TH	c	b		f	f	c	c	c	c	c	c	0	0	0	a		
106	12/05	a	a	d	O	5	if	a	d	a	9	aeh	a	a	aef, CW	a	a	a	a	c	b	c	e	30	20	0	a		
107	12/12	a	b	f	BE	0.1	ha	a	b	a	1	bcg	a	a	abf	a	b	b	b	c	c	b	d	20	0	10	a		
108	12/18	a	a	g	CM	0.01	ea	b	b	b	0	secret recipe	c	b		b	f	c	c	c	c	c	c	0	0	0	a		

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